DUDLEY KNOX LIBRARY
NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA 93943

NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

PRELIMINARY HELICOPTER DESIGN DECISION MAKING BASED ON FLIGHT PERFORMANCE FACTORS

by

Patrick V. Adamcik

September 1984

Thesis Advisor: Donald M. Layton

Approved for public release: Distribution unlimited

T221683

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
Preliminary Helicopter Design Decision Making Based on Flight Performance Factors

5. TYPE OF REPORT & PERIOD COVERED
Master's Thesis
September 1984

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
Patrick V. Adamcik

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Naval Postgraduate School
Monterey, California 93943

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
Naval Postgraduate School
Monterey, California 93943

12. REPORT DATE
September 1984

13. NUMBER OF PAGES
97

14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)
Approved for public release, distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)
Helicopter Design, Helicopter Performance, Helicopter Flight Performance, Helicopter Performance Factors

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This thesis will assist those evaluating helicopter design to make preliminary judgments about the feasibility of new designs. By using the computer program developed in this thesis, a designer can produce estimates for power requirements, endurance velocity, rate of climb, range velocity, hover ceiling, and service ceiling versus main rotor radius. These

20. continuation

estimates can also be examined for the effects of changes in main rotor radius, chord, and rotational velocity.

Approved for public release; distribution unlimited

Preliminary Helicopter Design Decision Making Based on Flight Performance Factors

by

Patrick V. Adamcik
Captain, United States Army
B.S., University of Texas at Austin, 1977

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN AERONAUTICAL ENGINEERING

from the

NAVAL POSTGRADUATE SCHOOL
September 1984

DUDLEY KNOX LIBRARY
NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA 93943

ABSTRACT

This thesis will assist those evaluating helicopter design to make preliminary judgments about the feasibility of new designs. By using the computer program developed in this thesis, a designer can produce estimates for power requirements, endurance velocity, rate of climb, range velocity, hover ceiling, and service ceiling versus main rotor radius. These estimates can also be examined for the effects of changes in main rotor radius, chord, and rotational velocity.

DUDLEY KNOX LIBRARY
NAVAL POSTGRADUATE SCHOOL
MONTEREY, CALIFORNIA 93943

TABLE OF CONTENTS

I. INTRODUCTION 9

II. APPROACH TO THE PROBLEM 11

III. SOLUTION TO THE PROBLEM 13

IV. RESULTS 18

V. CONCLUSIONS 24

APPENDIX A. COMPUTER PROGRAM OUTPUT - PLOTS 25

APPENDIX B. COMPUTER PROGRAM LISTING 57

LIST OF REFERENCES 96

INITIAL DISTRIBUTION LIST 97

LIST OF TABLES

1. Sample Data for Use in Program 13

2. Assumptions Made in the Program 14

3. Case Use of Variables 15

4. Case Evaluation of Maximum Rate of Climb 19

LIST OF FIGURES

3.1	Example of Left Hand Plot	16
3.2	Example of Right Hand Plot	17
4.1	Example Maximum Rate of Climb - Case 1	20
4.2	Example Maximum Rate of Climb - Case 2	21
4.3	Example Maximum Rate of Climb - Case 3	22
4.4	Example Maximum Rate of Climb - Case 4	23

ACKNOWLEDGMENT

Acknowledgment is made of the assistance provided by Professor Donald M. Layton, thesis advisor , who helped in guiding the direction of this thesis. Much of the necessary information for this thesis was found during Professor Layton's exellent classes on performance and design of helicopters.

I. INTRODUCTION

A military engineering officer in a program or project office would probably never be called on to prepare a conceptual design of a helicopter, but he may well be required to evaluate a proposal submitted by a commercial contractor.

The requirement for such an evaluation might be stated as:

> Determine if this design meets or exceeds the performance factors listed on the next page and if the design can be changed to optimize the performance.

There are several approaches one could use to complete this task. One could use a hand held calculator and enter the data for the many equations, or one could write a program for a micro or main frame computer to produce the required information. Both these options are laborious and time-consuming. By choosing the first option, one may be able to complete the task in two or three weeks or if it is decided to write a program, one may finish in one week provided that there are no "bugs".

The best solution of course, is to use an existing program which can determine the necessary information for the specification parameters. In addition, this program should be able to show what happens if certain parameters

are allowed to vary, thus providing the formation for optimization.

The objective of this thesis was to develop such a program that will graphically represent power requirements, endurance velocity, rate of climb, range velocity, hover ceiling and service ceiling all as a function of main rotor radius for four different cases. The graphs that result from this program should enable one not only to evaluate the basic helicopter design, but also to make recommendations for design improvement.

II. APPROACH TO THE PROBLEM

Six performance factors (power requirements, endurance velocity, rate of climb, range velocity, hover ceiling and service ceiling) were determined to be major in designing of a helicopter. In order to obtain estimates for these, a Fortran program was to be written to be used with "DISSPLA" (Display Integrated Software System and Plotting Language),[Ref. 1], to plot the results of the performance factors versus main rotor radius on either a screen or as a hard copy from the main frame computer.

The equations required for calculating these factors were obtained from "Helicopter Performance",[Ref. 2], and "Helicopter Design Manual",[Ref. 3], both written by Donald M. Layton. These equations were examined and then grouped for the purpose of writing subroutines to ensure an effective use of computer time. The result was six subroutines, Sub-group A, [Appendix B], are used in all the performance calculations. Sub-group A consist of:

1. RHO - Calculates density from pressure altitude and temperature or given density altitude. Also determines pressure and temperature ratio for altitude versus sea level.

2. VELMR - Calculates induced velocity for main rotor.

3. VELTR - Calculates induced velocity for tail rotor.

4. POWMR - Calculates power requirements for main rotor only.

5. POWTR - Calculates power requirements for tail rotor and total aircraft.

6. CONST - Calculates general constants to be used in the first five subroutines listed above.

In addition to the subroutines listed above, six more, Sub-group B, [Appendix B], were written to perform the necessary iterations to calculate the performance factors. Some of Sub-group B subroutines were iterated in steps (1000,100,10,1) so that it would not require extensive computer time to obtain the desired results. A final eight subroutines, Sub-group C, [Appendix B], were written to plot the results using DISSPLA.

The program takes into account neither compressibility nor blade stall. These considerations were omitted since this program was aimed at facilitating preliminary decision making for a new design, rather than a final production design, and usually the blade selected for a new design is taken from an existing helicopter.

III. SOLUTION TO THE PROBLEM

The program requires input data prior to compiling and execution. To demonstrate how to use the program a set of sample data was used. Table 1 is a listing of the required input data for the program.

Table 1

Sample Data for Use in Program

	Main Rotor	Tail Rotor
Radius	26.8 ft	5.5 ft
Chord	1.75 ft	0.81 ft
Rotational velocity	27.0 rad/sec	124.6 rad/sec
Coefficient of drag	0.008	0.008
Number of blades	4	4

General Helicopter Data

Weight	20000.0 lbs
Tail boom length	31.5 ft
Effective flat plate area (forward)	25.7 sq ft
Effective flat plate area (vertical)	31.8 sq ft
Main rotor height above skids or wheels	11.2 ft
Aircraft velocity (power calculations only)	90.0 kts
Plus/minus (+/-) value for main rotor radius	4.0 ft

Engine Data

Number of engines	2
Shaft horsepower output (military)	1561.0 shp
Shaft horsepower output (normal)	1318.0 shp
Shaft horsepower output (cruise)	989.0 shp
Specific fuel consumption (military)	0.46 lbs/shp/hr
Specific fuel consumption (normal)	0.47 lbs/shp/hr
Specific fuel consumption (cruise)	0.51 lbs/shp/hr

As indicated in Table 1, a value is inputted for the range over which you wish to examine the main rotor radius.

The example uses a value of four (4.0) feet. This value is assigned to a variable called "diff". The program was written to allow the X-axis scale of the plot to be adjusted in accordance with any value you might choose for "diff". The Y-axis scales can also change based on the maximum and minimum values for the performance factor being considered.

Certain assumptions had to be made in order to write the program. Table 2 lists these assumptions and factors used and the line number in the program where the factors can be changed if needed.

Table 2

Assumptions Made in the Program

Assumption	Factor	Line Number
Single Mast Helicopters	NA	NA
Only Rectangular Blades	NA	NA
Profile Power Factor	4.3	1079,1108
Ground Effect Factor	1.6	1138
Transmission & Accessory Losses		
1 engine SHP = (# ENG*ESHP-10.0)*0.97		560,780,887
2 engines SHP = (# ENG*ESHP-10.0)*0.9*0.97		561,781,888
3 engines SHP = (# ENG*ESHP-10.0)*0.9*0.94		562,782,889

ENG: Engine, ESHP: Engine shaft horsepower,
SHP: Rotor Shaft horsepower

The Transmission and Accessory Losses were calculated based on a loss of ten (10) horsepower for the accessories, ten percent (10%) for multiple engine installation, and three

percent (3%) for transmission losses (if three engines are used, an additional transmission is required), [Ref. 2].

The secondary goal of the thesis was to examine four (4) different cases involving main rotor Radius, Chord, Rotational Velocity, Tip Velocity, Advance Ratio, and Solidity. Table 3 shows how these variables were used in each of the four (4) cases.

Table 3

Case Use of Variables

	Radius	Chord	Rotational Velocity	Advance Ratio	Tip Velocity	Solidity
Case 1	V	C	C	V	V	V
Case 2	V	C	V	C	C	V
Case 3	V	V	C	V	V	C
Case 4	V	V	V	C	C	C

V : VARIES C : HELD CONSTANT

Advance Ratio, Tip Velocity, and Solidity when held constant keep their values at the specification conditions. The values of Chord and Rotational Velocity were allowed to vary when Advance Ratio, Tip Velocity, or Solidity were held constant as shown in Table 3.

The graphs consist of two (2) plots representing the same data but presented in different ways. The left hand plot shows the actual performance factor value versus main rotor radius. Figure 3.1 shows an example using power required versus main rotor radius, Case 1.

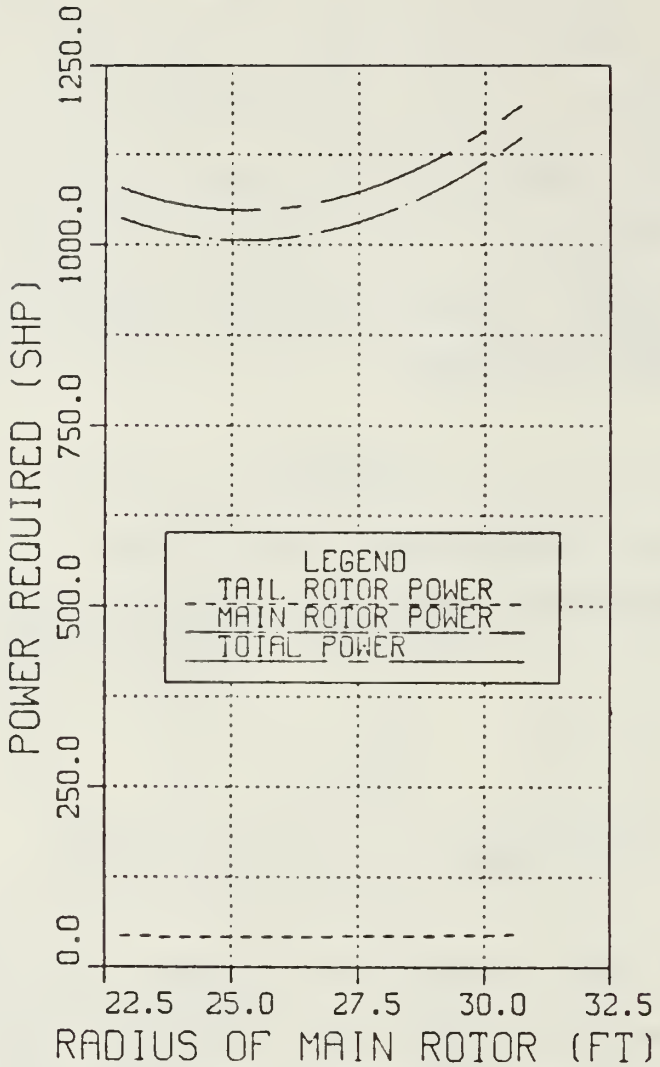


Figure 3.1 Example of Left Hand Plot

The right hand plot shows the values of the performance factors based on a percent difference from the value at the specification conditions versus a percent difference of the radius from the radius specification. Figure 3.2 shows an example of power required (% change) versus radius of the main rotor (% change), Case 1.

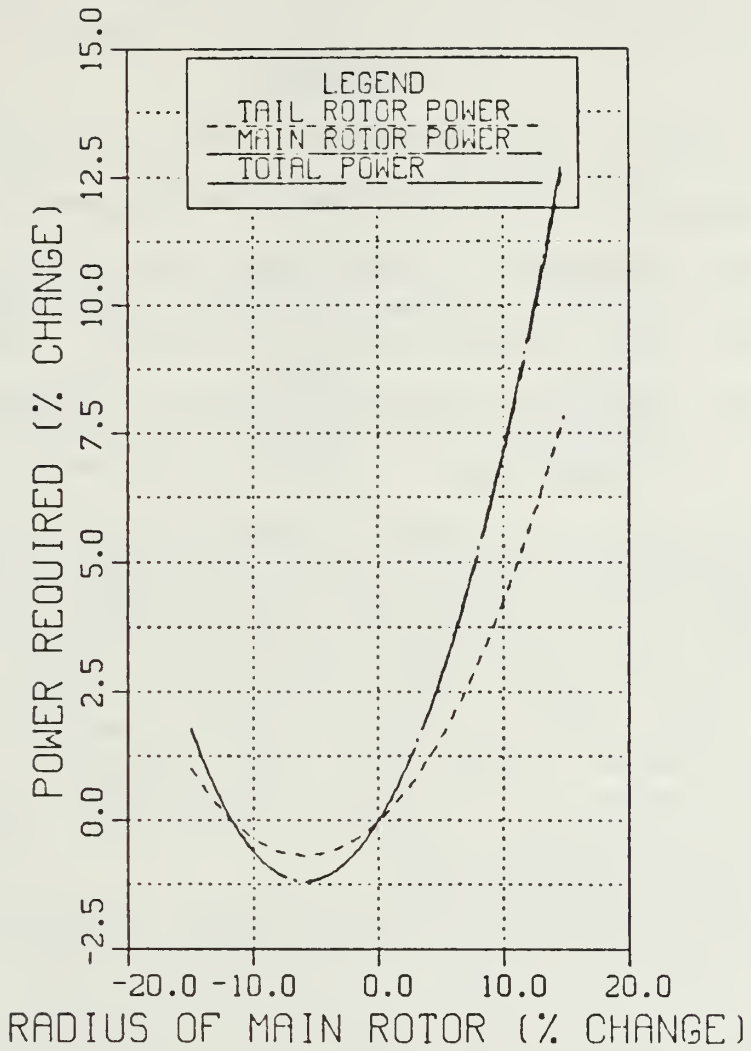


Figure 3.2 Example of Right Hand Plot

IV. RESULTS

The program will generate a total of thirty two (32) plots. The first twelve (12) pertain to power requirements. This includes induced, profile, and parasite power for the main rotor; and induced and profile power for the tail rotor. To indicate a relation between the power terms of the main rotor the figure of merit (induced divided by the sum of the induced and profile power) is included. The sum of the terms (total power) for the main and tail rotor was included with the total power required for the aircraft. The remaining twenty (20) plots are for the performance factors of endurance velocity, rate of climb, range velocity, hover ceiling and service ceiling.

The data for this particular model (UH-60A) was used to illustrate the features of the program and the results presented are typical for this example only. The specifications of any model or design can be used as long as the assumption of a single-mast helicopter with rectangular blades is followed.

The plots created by the program represent the results of varying the main rotor radius, chord or rotational velocity. To example how to interrupt the results, the four (4) plots for Maximum Rate of Climb will be analyzed. Table 4 compares the results in relation to rate of climb, radius

and percent increase of rate of climb. The cases were explained in Table 3 and the Figures follow Table 4.

Table 4

Case Evaluation of Maximum Rate of Climb Plots

Case	Figure Reference	Rate of Climb(ft/sec)	Radius (ft)	Percent Increase
1	4.1	2628	27.8	+ 0.130
2	4.2	2668	24.8	- 0.156
3	4.3	2700	30.63	+ 2.80
4	4.4	2637	25.63	- 5.00

From examining Table 4, it would be best to increase the radius to 30.63 feet while holding the chord to 1.75 feet. the tip velocity to 723.6 ft/sec (radius times rotational velocity), changing the rotational velocity to 23.62 rad/sec, and calculating solidity from radius and chord. This, however, may not be the best answer if there is a limitation to the radius of the blade. For this particular example, the optimum solution may be to leave the design as it is. Increasing or decreasing the radius by small amounts does little to increase or decrease the rate of climb.

One must not only look at one factor in making the final decision. The changes affect the performance factors in different ways, therefore, the final decision must be made after weighting all the changes against all the performance factors.

Figure 4.1 Example Maximum Rate of Climb - Case 1

Figure 4.2 Example Maximum Rate of Climb - Case 2

Figure 4.3 Example Maximum Rate of Climb - Case 3

Figure 4.4 Example Maximum Rate of Climb - Case 4

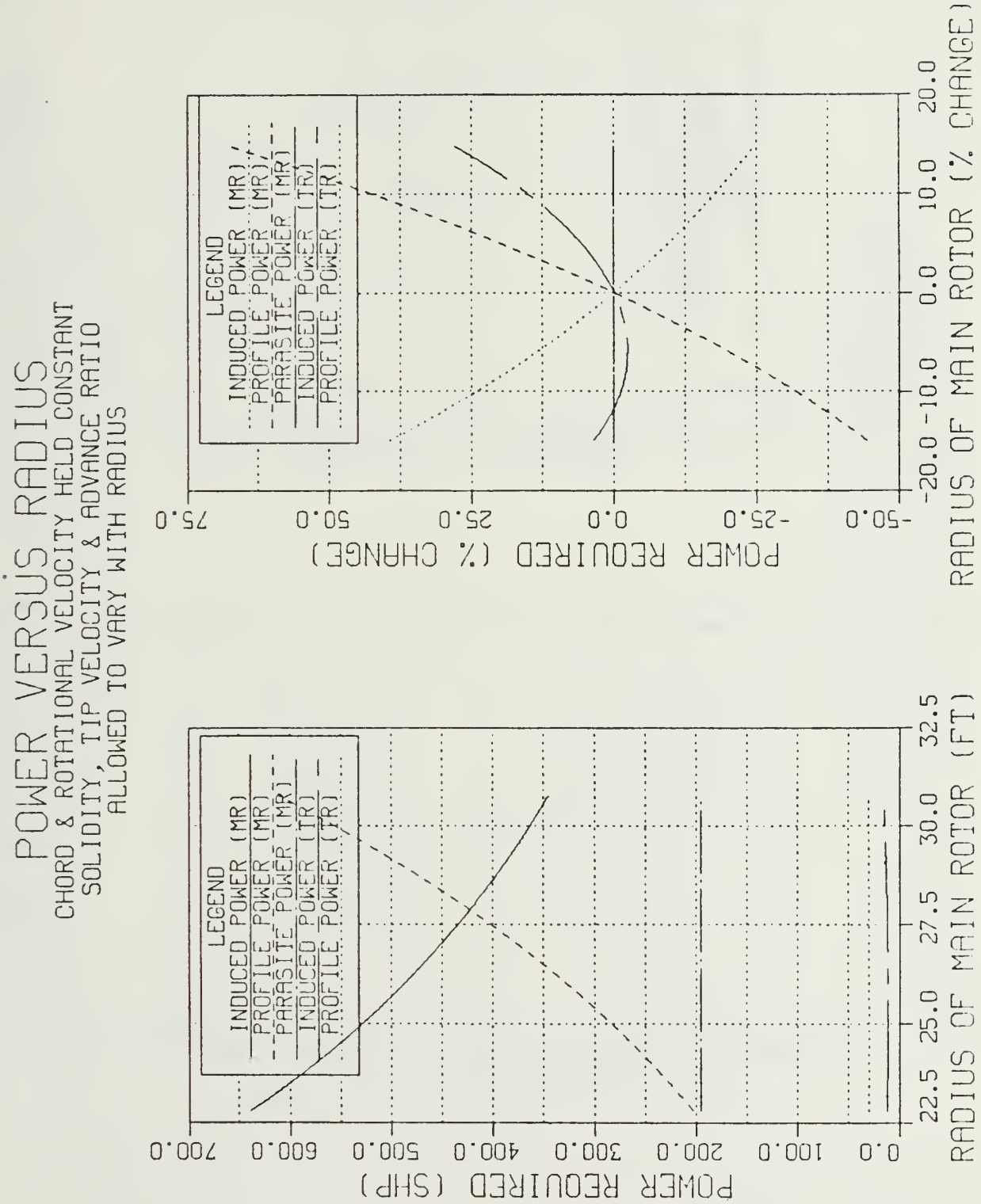
V. CONCLUSIONS

The objective of this thesis to design a program that evaluates a given set of helicopter design values was accomplished. The program will generate thirty two (32) graphs of six (6) performance factors for any single-mast helicopter. The program does allow for one to optimize a design through the evaluation of the variation of parameters for each performance factor.

At this point, the program takes into account neither compressibility nor blade stall. These factors would improve the estimations and may prove to be a worthwhile project for further work. Other points which could be examined are twin-blade and no-tail-rotor helicopters. Of the points mentioned above, blade design would probably be of most importance since little has been done to examine the optimization of blade twist and composite structure of blades.

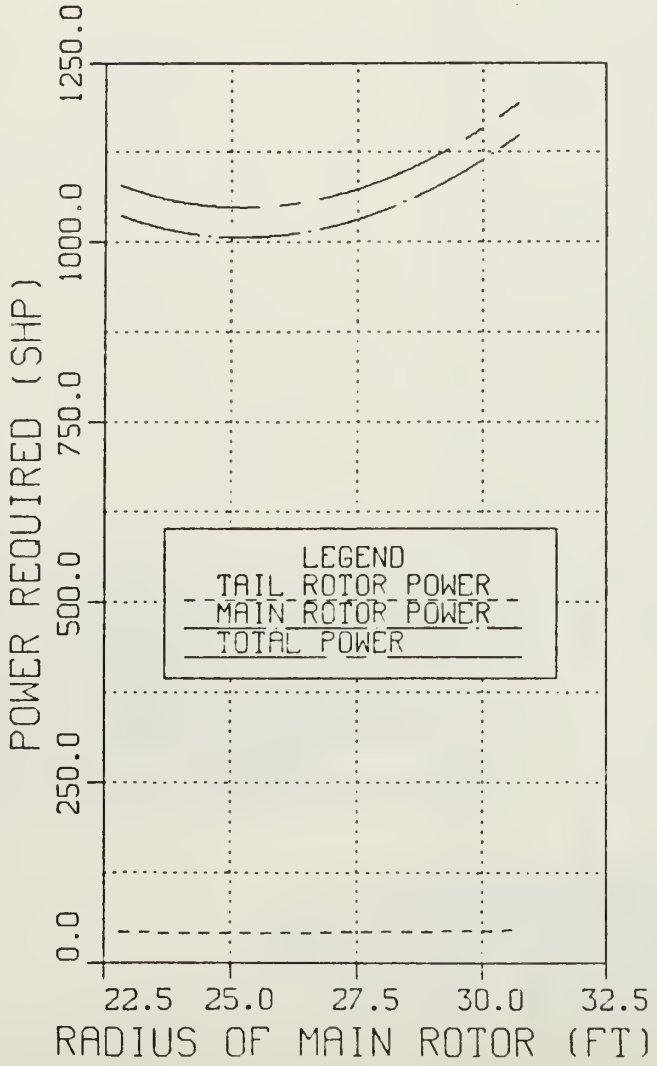
APPENDIX A

COMPUTER PROGRAM OUTPUT - PLOTS



POWER VERSUS RADIUS

CHORD & ROTATIONAL VELOCITY HELD CONSTANT
SOLIDITY, TIP VELOCITY & ADVANCE RATIO
ALLOWED TO VARY WITH RADIUS



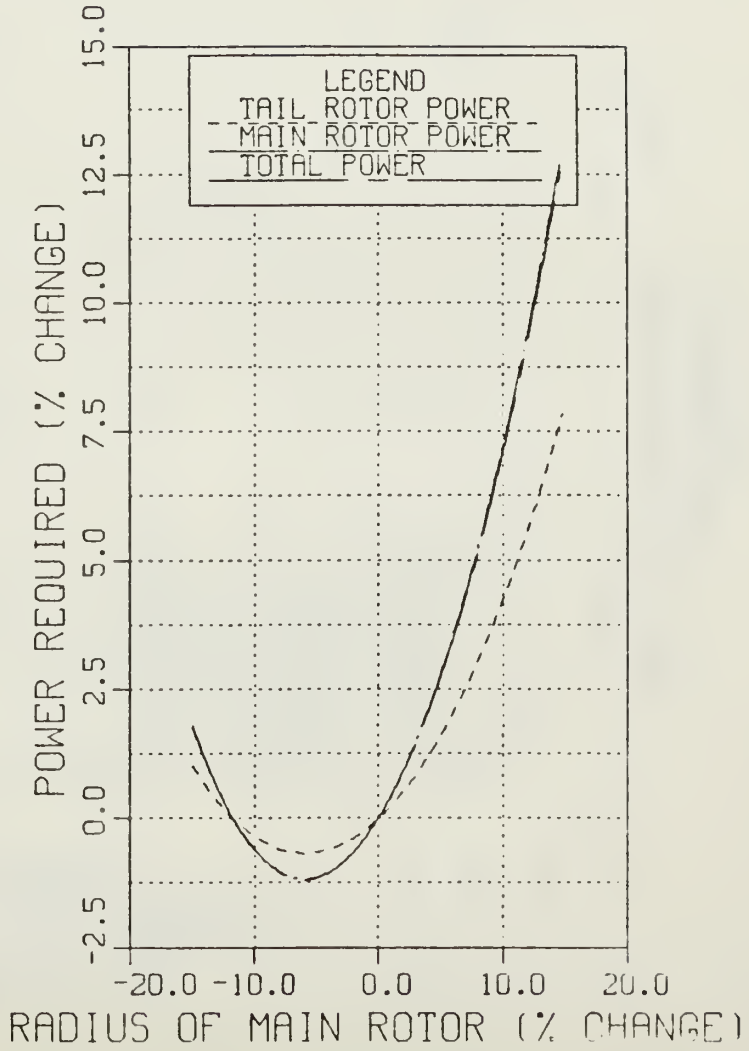
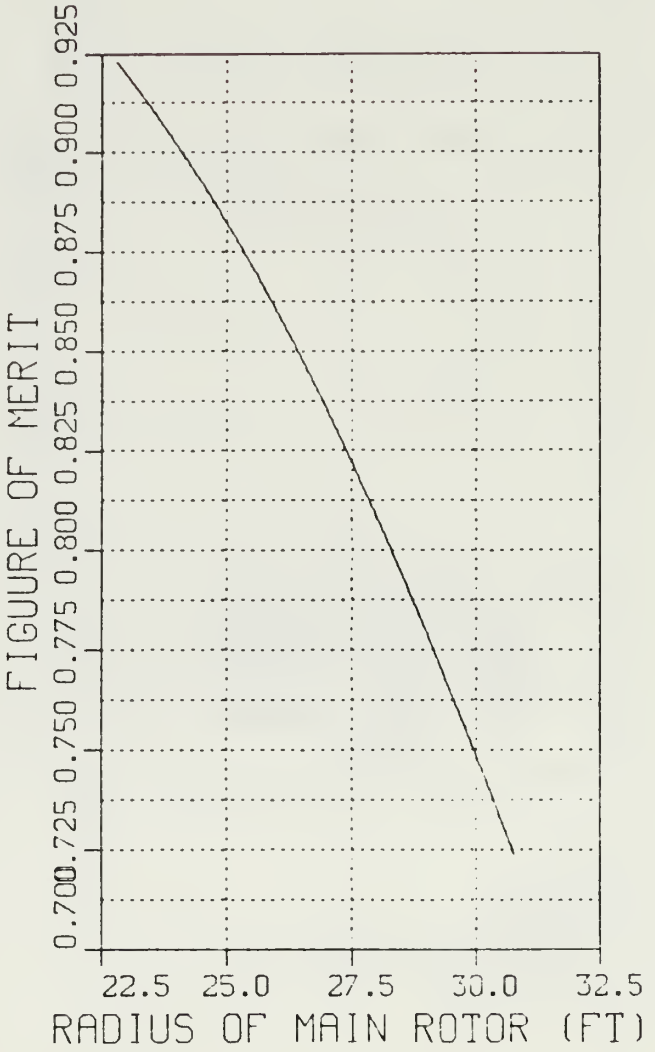
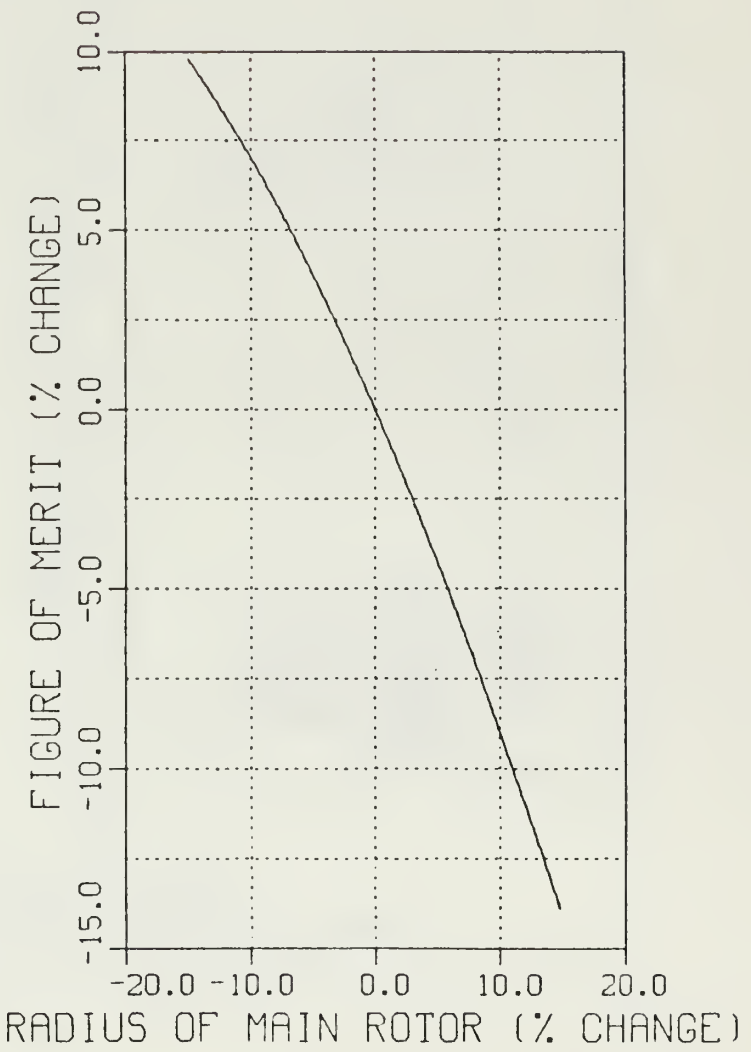


FIGURE OF MERIT VERSUS RADIUS CHANGE

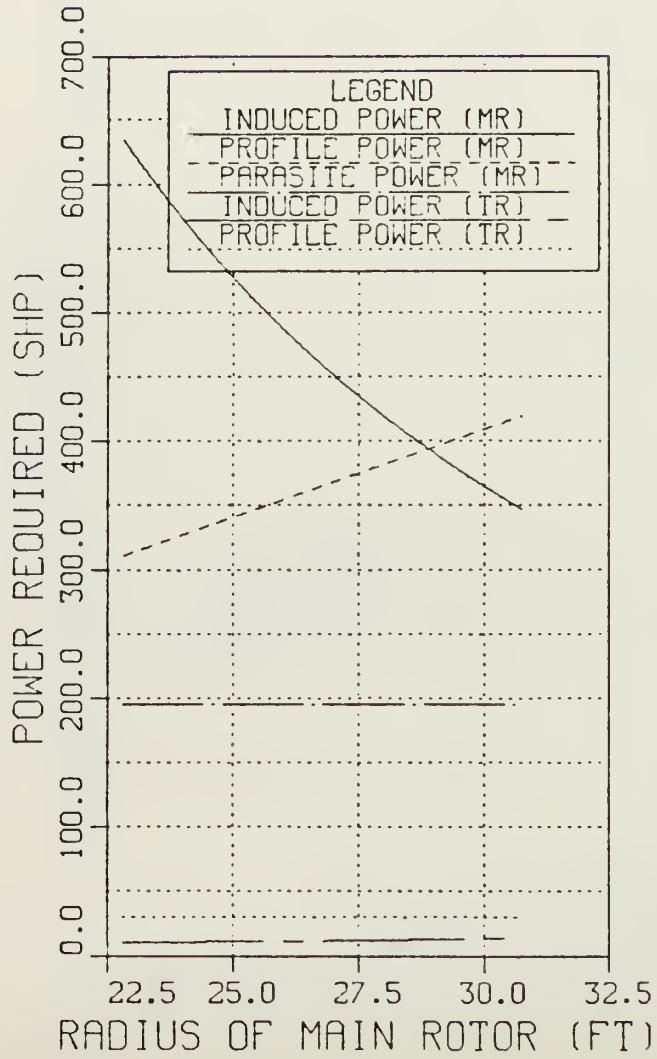
CHORD & ROTATIONAL VELOCITY HELD CONSTANT
SOLIDITY, TIP VELOCITY & ADVANCE RATIO
ALLOWED TO VARY WITH RADIUS

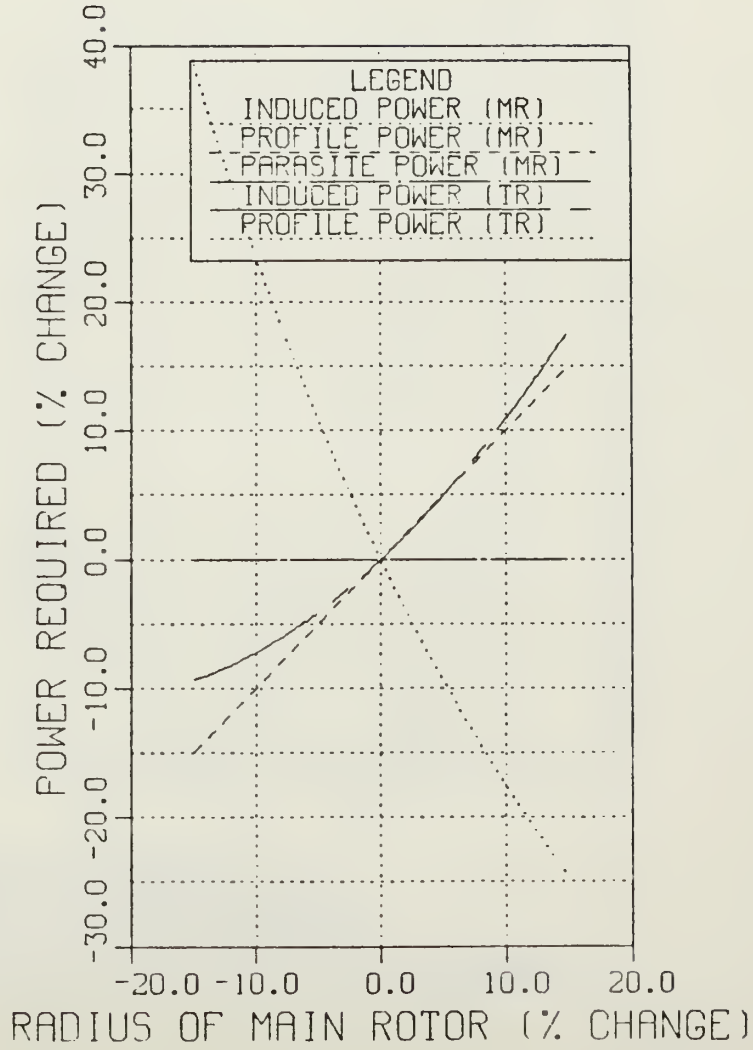




POWER VERSUS RADIUS

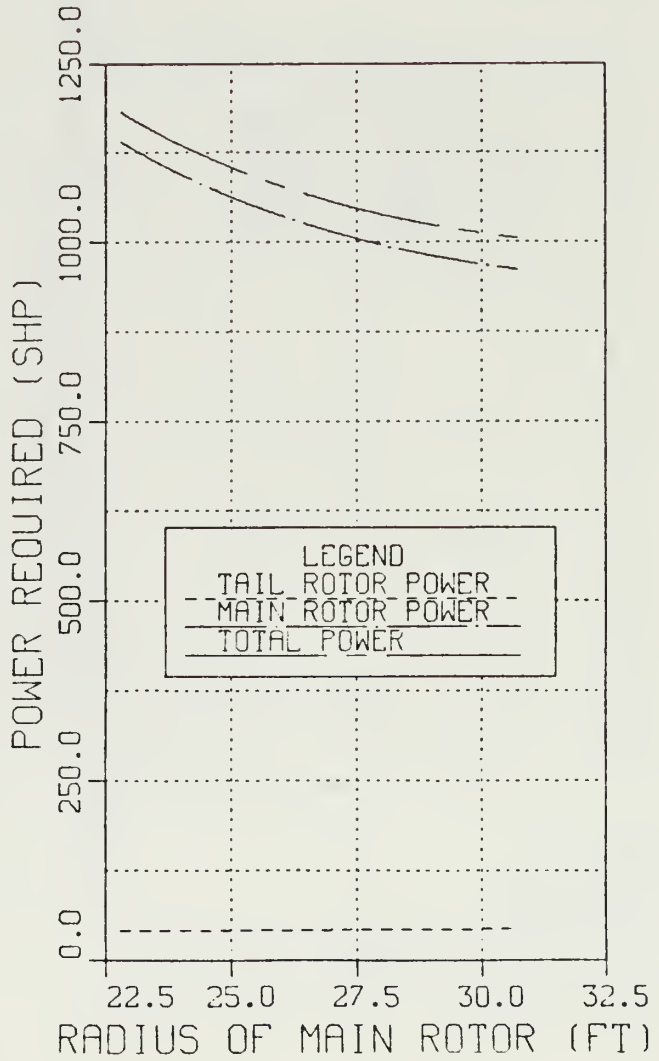
CHORD, TIP VELOCITY & ADVANCE RATIO HELD CONSTANT
SOLIDITY, ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS





POWER VERSUS RADIUS

CHORD, TIP VELOCITY & ADVANCE RATIO HELD CONSTANT
SOLIDITY, ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS



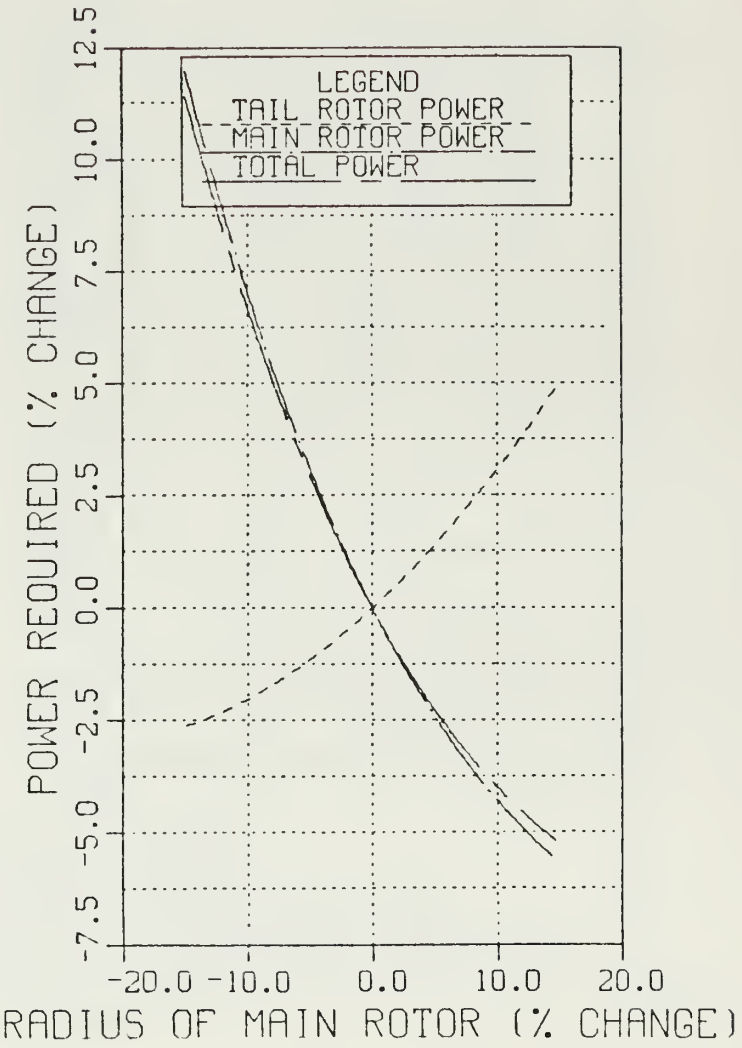
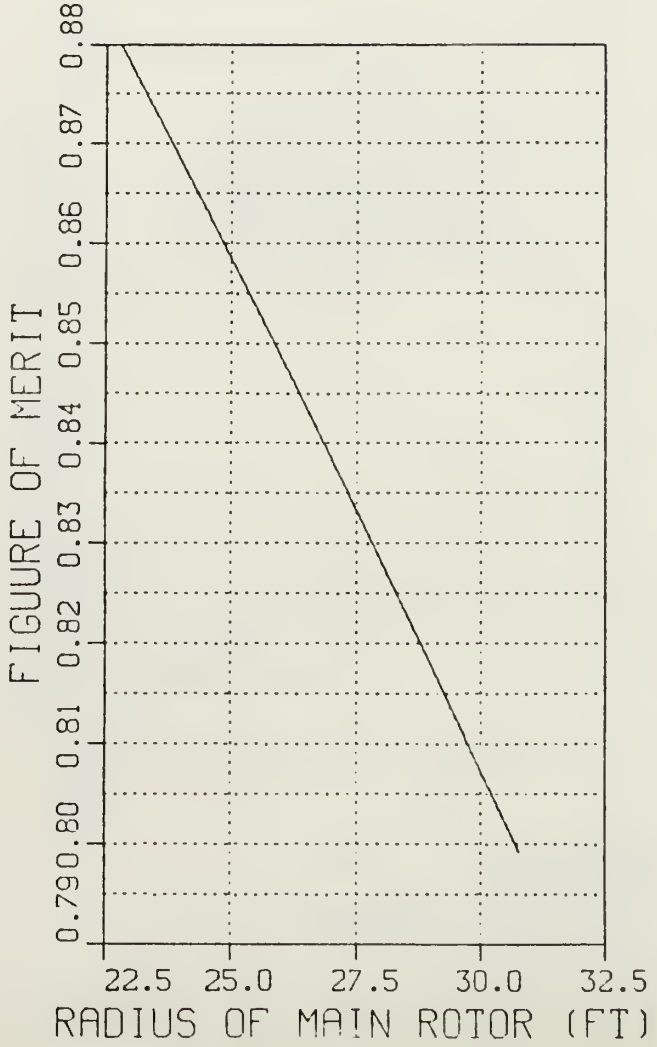
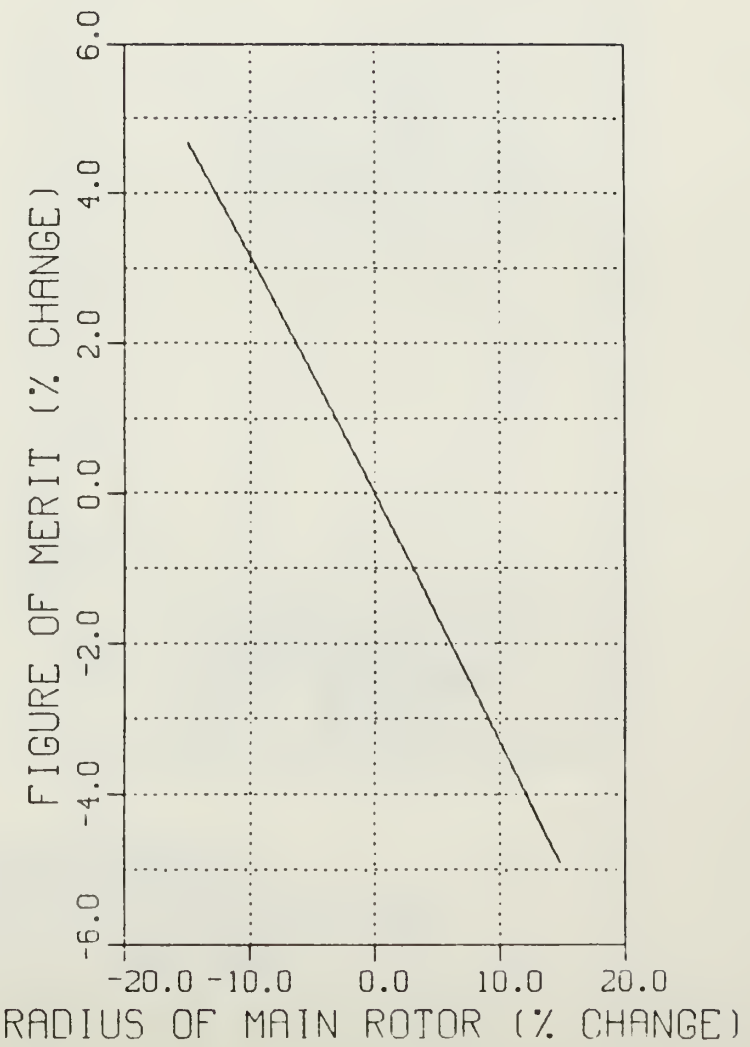


FIGURE OF MERIT VERSUS RADIUS CHANGE

CHORD, TIP VELOCITY & ADVANCE RATIO HELD CONSTANT
SOLIDITY, ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS

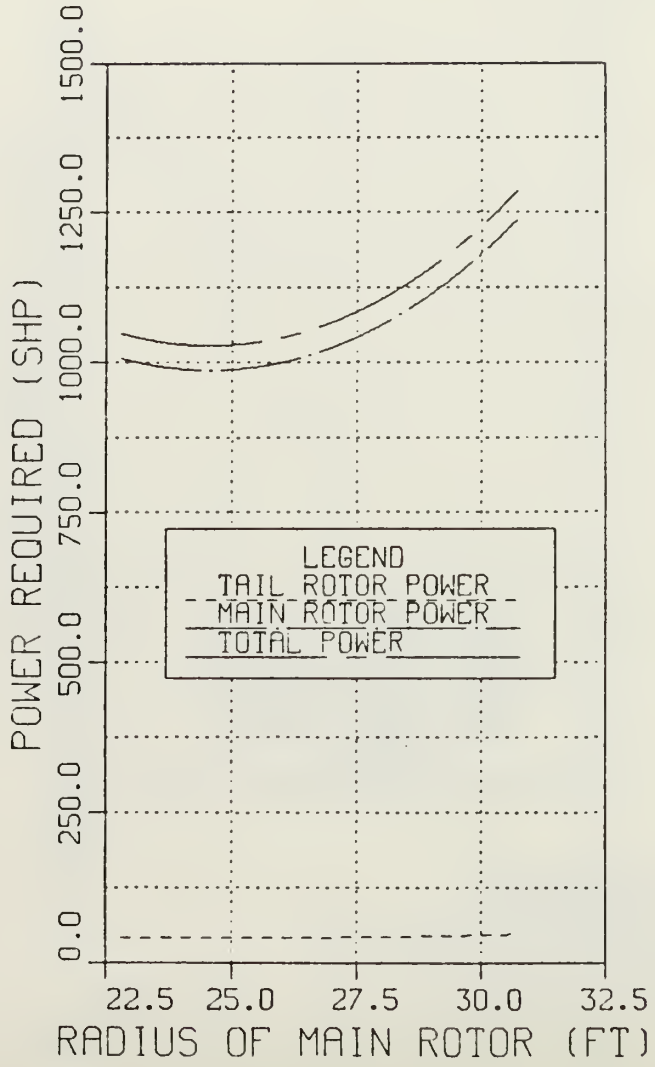




POWER VERSUS RADIUS
SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT
CHORD,ADVANCE RATIO & TIP VELOCITY
ALLOWED TO VARY WITH RADIUS
LEGEND
INDUCED POWER (MR)
PROFILE POWER (MR)
PARASITE POWER (MR)
INDUCED POWER (TR)
PROFILE POWER (TR)
POWER REQUIRED (SHP)
0.0
100.0
200.0
300.0
400.0
500.0
600.0
700.0
800.0
22.5
25.0
27.5
30.0
32.5
RADIUS OF MAIN ROTOR (FT)
POWER REQUIRED (% CHANGE)
100.0
75.0
50.0
25.0
0.0
-25.0
-50.0
-75.0
-20.0
-10.0
0.0
10.0
20.0
RADIUS OF MAIN ROTOR (% CHANGE)

POWER VERSUS RADIUS

SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT
CHORD, ADVANCE RATIO & TIP VELOCITY
ALLOWED TO VARY WITH RADIUS



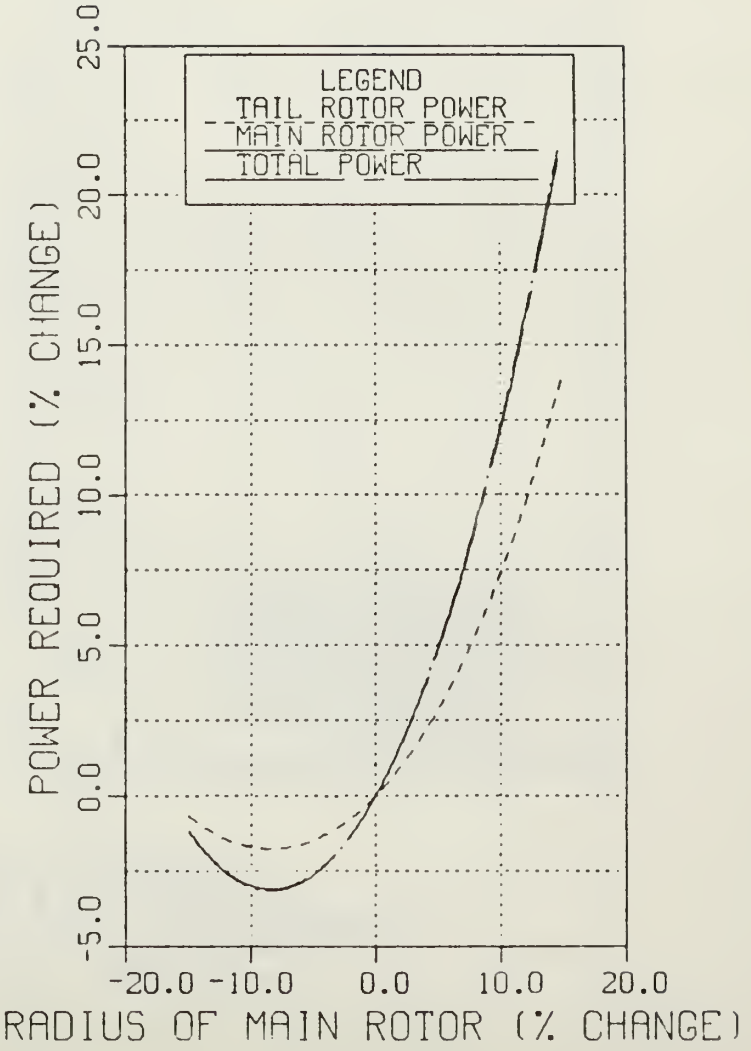
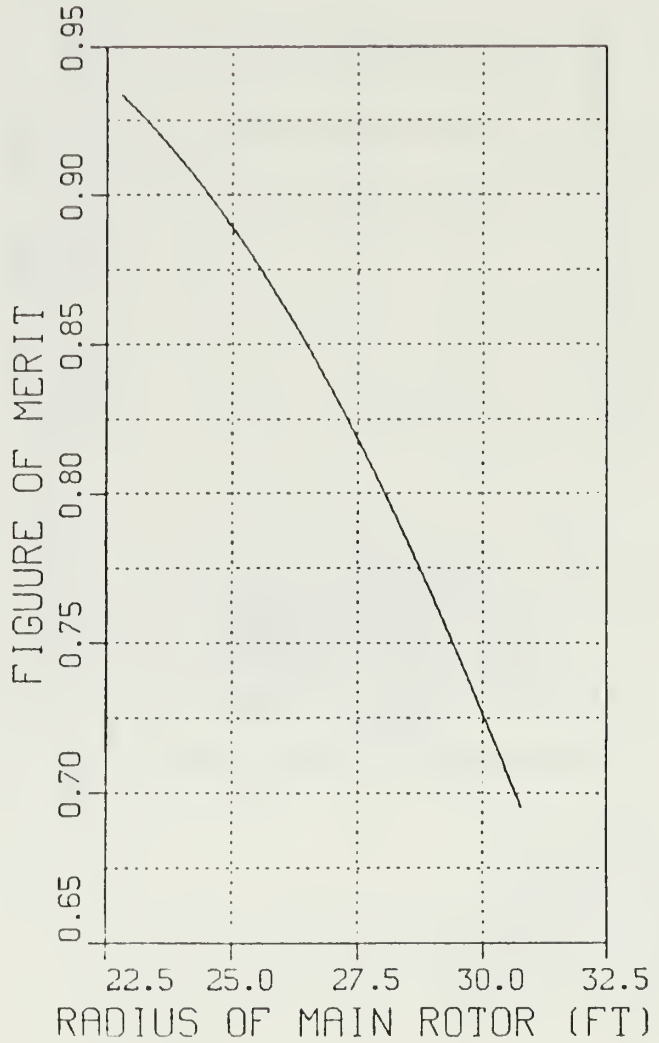
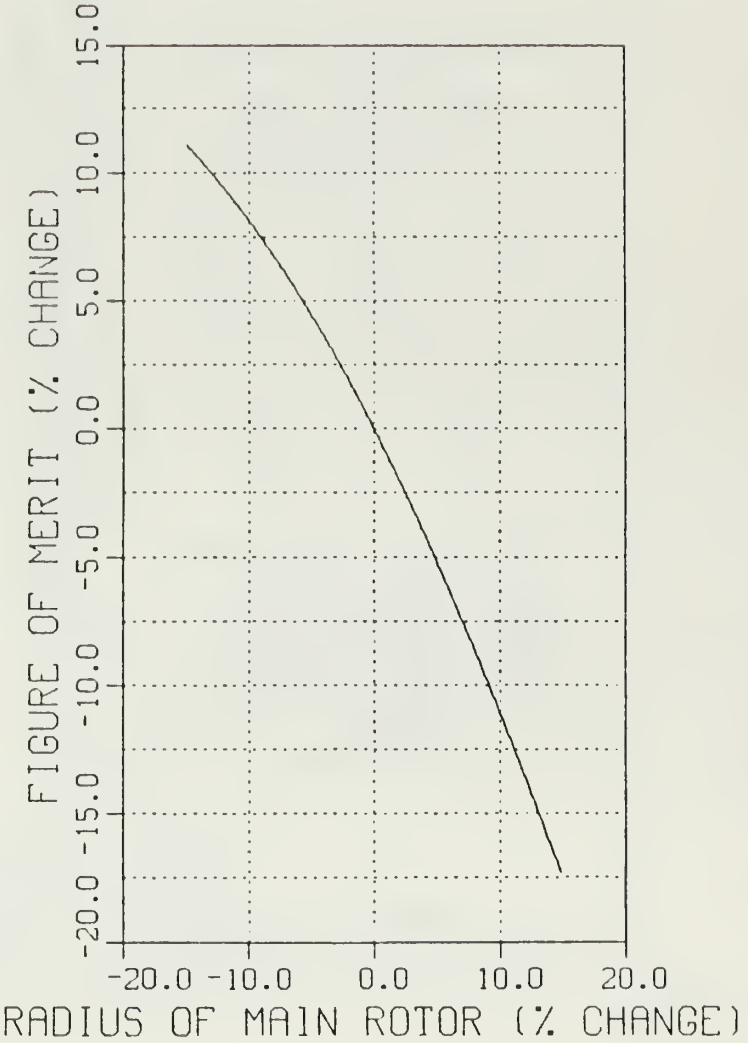


FIGURE OF MERIT VERSUS RADIUS CHANGE

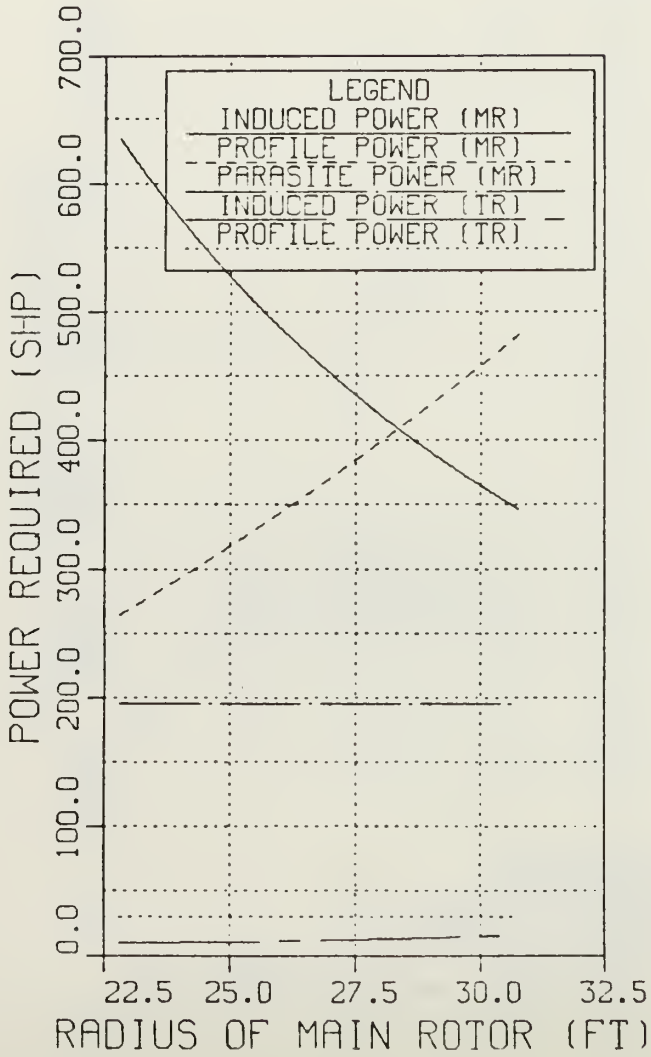
SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT
CHORD, ADVANCE RATIO & TIP VELOCITY
ALLOWED TO VARY WITH RADIUS

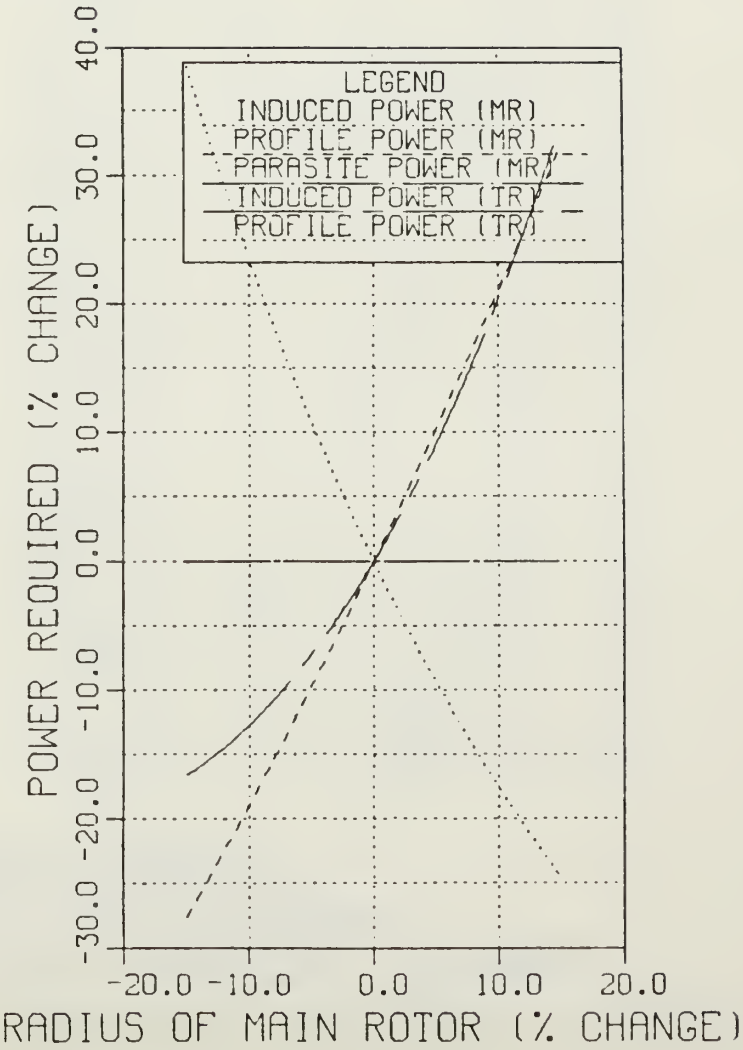




POWER VERSUS RADIUS

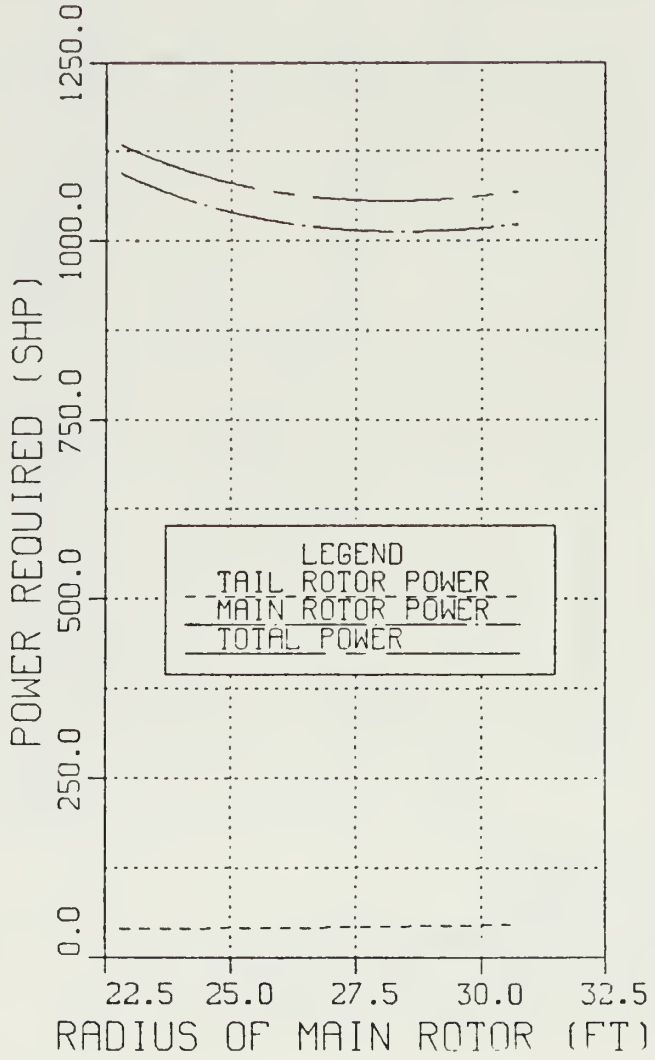
SOLIDITY, ADVANCE RATIO & TIP VELOCITY HELD CONSTANT
CHORD & ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS





POWER VERSUS RADIUS

SOLIDITY, ADVANCE RATIO & TIP VELOCITY HELD CONSTANT
CHORD & ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS



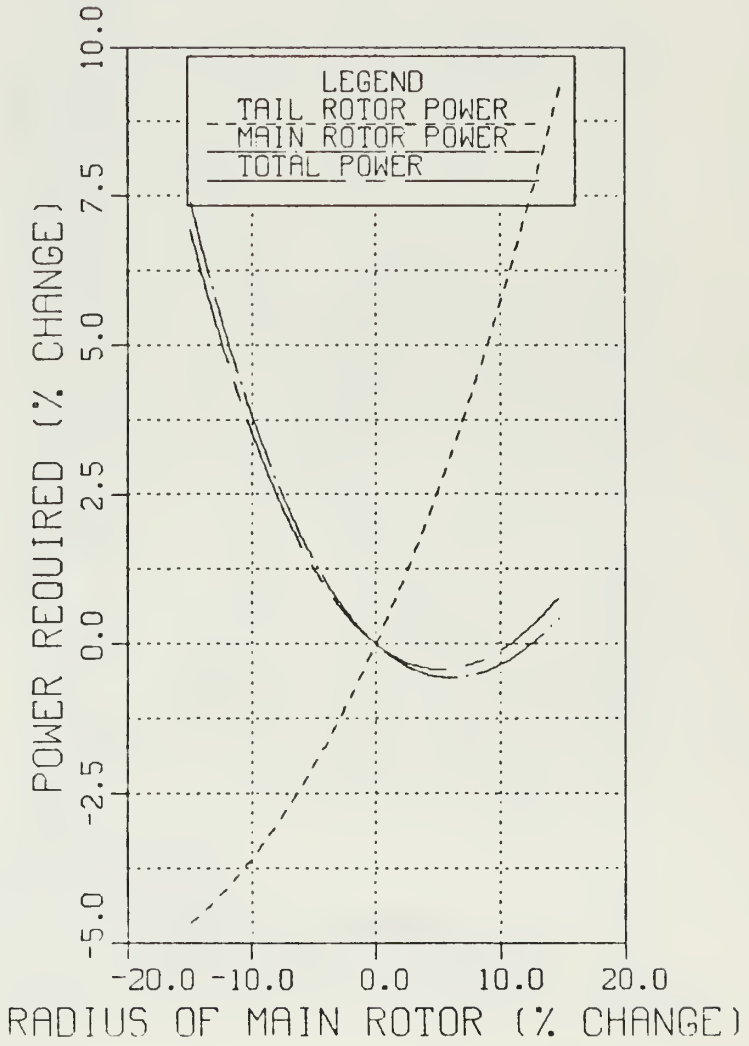
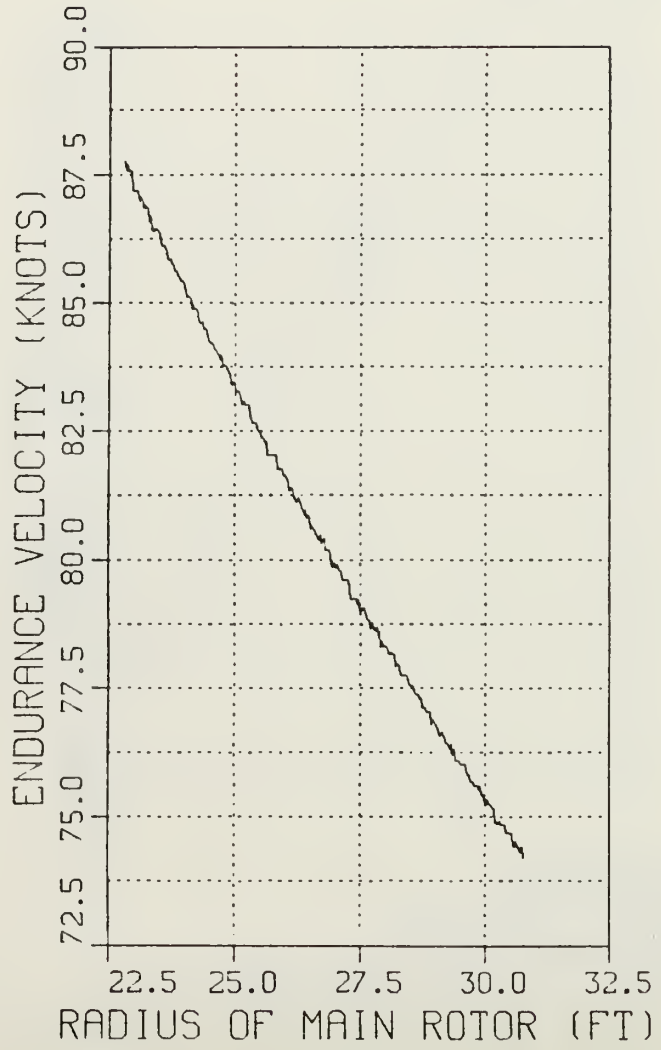


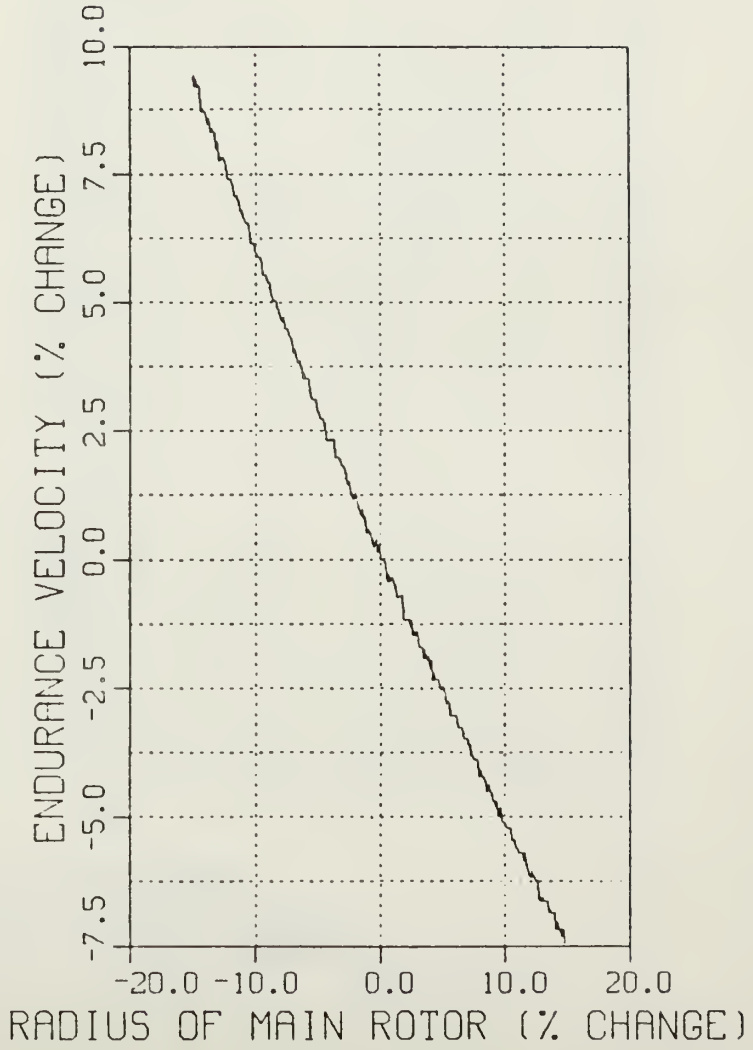
FIGURE OF MERIT VERSUS RADIUS CHANGE
SOLIDITY, ADVANCE RATIO & TIP VELOCITY HELD CONSTANT
CHORD & ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS
FIGURE OF MERIT
0.775
0.800
0.825
0.850
0.875
0.900
RADIUS OF MAIN ROTOR (FT)
22.5
25.0
27.5
30.0
32.5
FIGURE OF MERIT (% CHANGE)
-10.0
-7.5
-5.0
-2.5
0.0
2.5
5.0
7.5
RADIUS OF MAIN ROTOR (% CHANGE)
-20.0
-10.0
0.0
10.0
20.0

ENDURANCE VELOCITY VERSUS RADIUS
CHORD & ROTATIONAL VELOCITY HELD CONSTANT
SOLIDITY, TIP VELOCITY & ADVANCE RATIO
ALLOWED TO VARY WITH RADIUS
ENDURANCE VELOCITY (KNOTS)
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
RADIUS OF MAIN ROTOR (FT)
22.5
25.0
27.5
30.0
32.5
ENDURANCE VELOCITY (% CHANGE)
12.5
10.0
7.5
5.0
2.5
0.0
-2.5
-5.0
-7.5
-10.0
RADIUS OF MAIN ROTOR (% CHANGE)
-20.0
-10.0
0.0
10.0
20.0

ENDURANCE VELOCITY VERSUS RADIUS

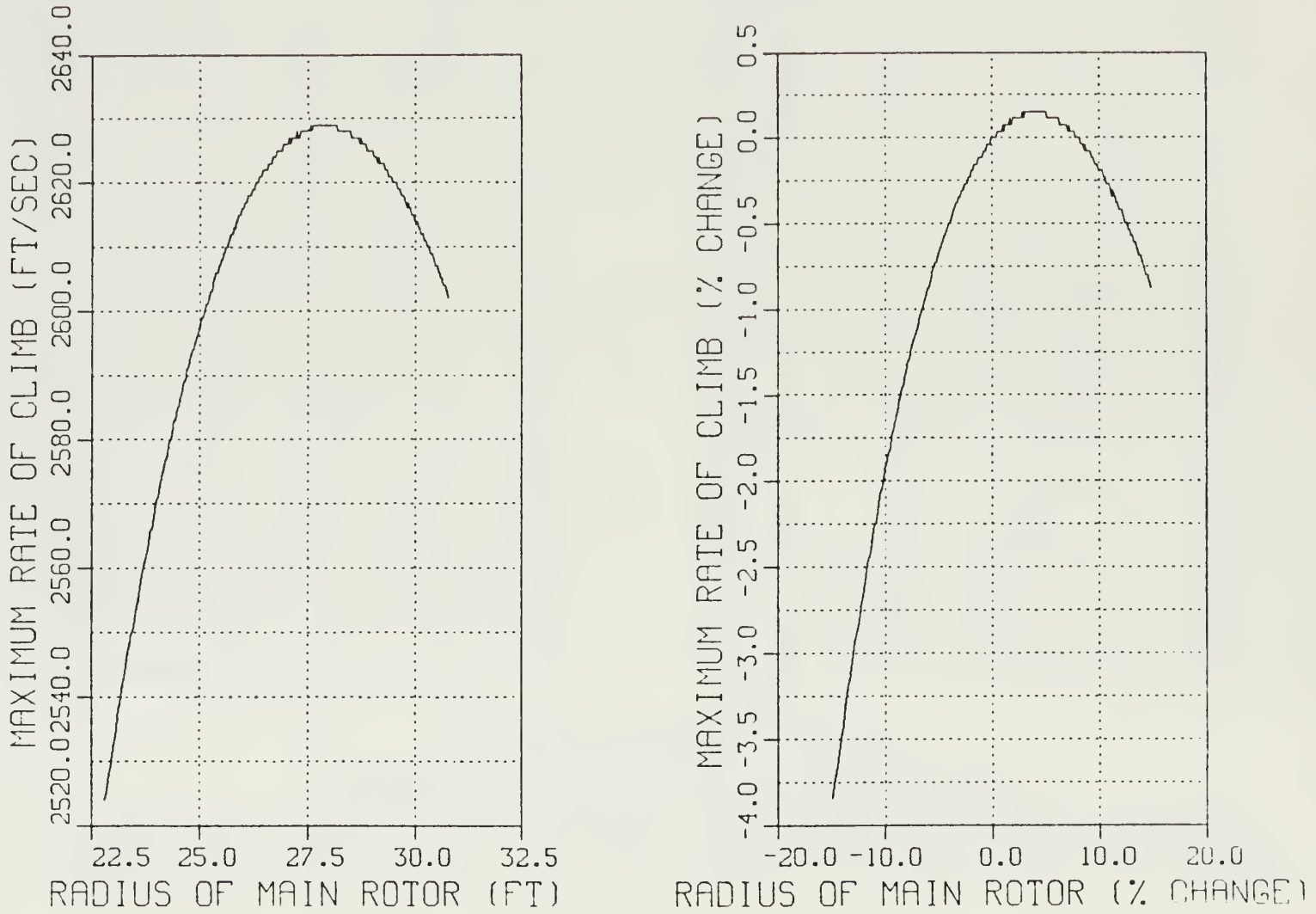
CHORD, TIP VELOCITY & ADVANCE RATIO HELD CONSTANT
SOLIDITY, ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS





ENDURANCE VELOCITY VERSUS RADIUS
SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT
CHORD,ADVANCE RATIO & TIP VELOCITY
ALLOWED TO VARY WITH RADIUS
ENDURANCE VELOCITY (KNOTS)
72.5 75.0 77.5 80.0 82.5 85.0 87.5 90.0
RADIUS OF MAIN ROTOR (FT)
22.5 25.0 27.5 30.0 32.5
ENDURANCE VELOCITY (% CHANGE)
-10.0 -7.5 -5.0 -2.5 0.0 2.5 5.0 7.5 10.0 12.5
RADIUS OF MAIN ROTOR (% CHANGE)
-20.0 -10.0 0.0 10.0 20.0

ENDURANCE VELOCITY VERSUS RADIUS
SOLIDITY, ADVANCE RATIO & TIP VELOCITY HELD CONSTANT
CHORD & ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS
ENDURANCE VELOCITY (KNOTS)
90.0
87.5
85.0
82.5
80.0
77.5
75.0
72.5
RADIUS OF MAIN ROTOR (FT)
22.5
25.0
27.5
30.0
32.5
ENDURANCE VELOCITY (% CHANGE)
10.0
7.5
5.0
2.5
0.0
-2.5
-5.0
-7.5
-10.0
RADIUS OF MAIN ROTOR (% CHANGE)
-20.0
-10.0
0.0
10.0
20.0


MAXIMUM RATE OF CLIMB VERSUS RADIUS CHANGE
SOLIDITY, ADVANCE RATIO & TIP VELOCITY HELD CONSTANT
CHORD & ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS
MAXIMUM RATE OF CLIMB (FT/SEC)
2520.0 2540.0 2560.0 2580.0 2600.0 2620.0 2640.0
22.5 25.0 27.5 30.0 32.5
RADIUS OF MAIN ROTOR (FT)
MAXIMUM RATE OF CLIMB (% CHANGE)
-4.0 -3.5 -3.0 -2.5 -2.0 -1.5 -1.0 -0.5 0.0 0.5
-20.0 -10.0 0.0 10.0 20.0
RADIUS OF MAIN ROTOR (% CHANGE)

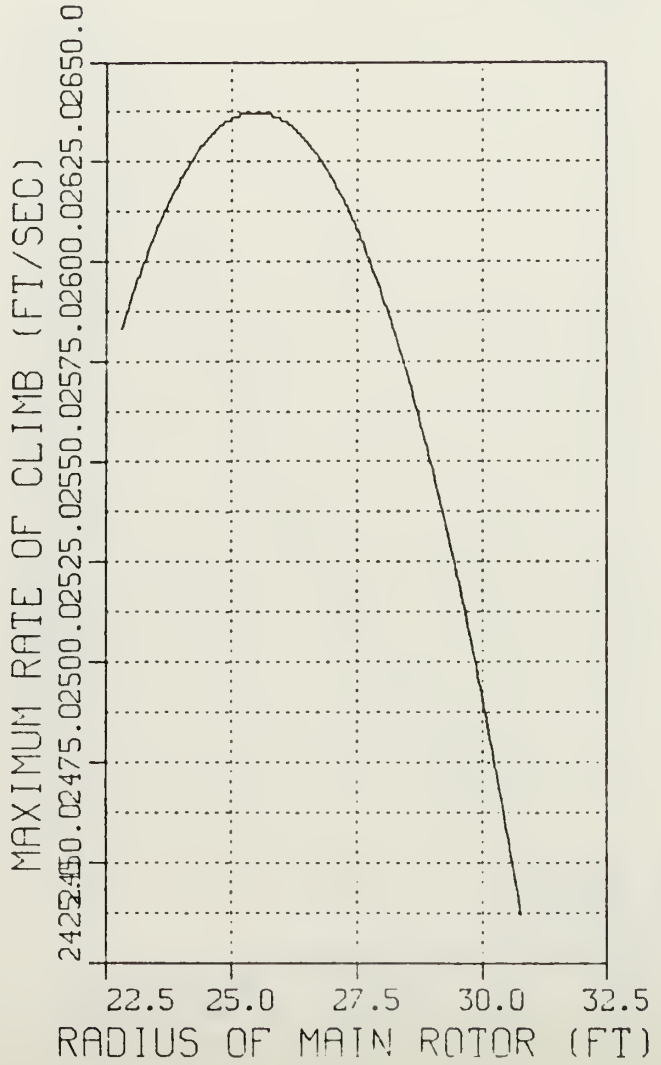
MAXIMUM RATE OF CLIMB VERSUS RADIUS CHANGE
SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT
CHORD,ADVANCE RATIO & TIP VELOCITY
ALLOWED TO VARY WITH RADIUS
MAXIMUM RATE OF CLIMB (FT/SEC)
2250 2300 .0235 .0240 .0245 .0250 .0255 .0260 .0265 .0270 .0
22.5 25.0 27.5 30.0 32.5
RADIUS OF MAIN ROTOR (FT)
MAXIMUM RATE OF CLIMB (% CHANGE)
-15.0 -12.5 -10.0 -7.5 -5.0 -2.5 0.0 2.5
-20.0 -10.0 0.0 10.0 20.0
RADIUS OF MAIN ROTOR (% CHANGE)

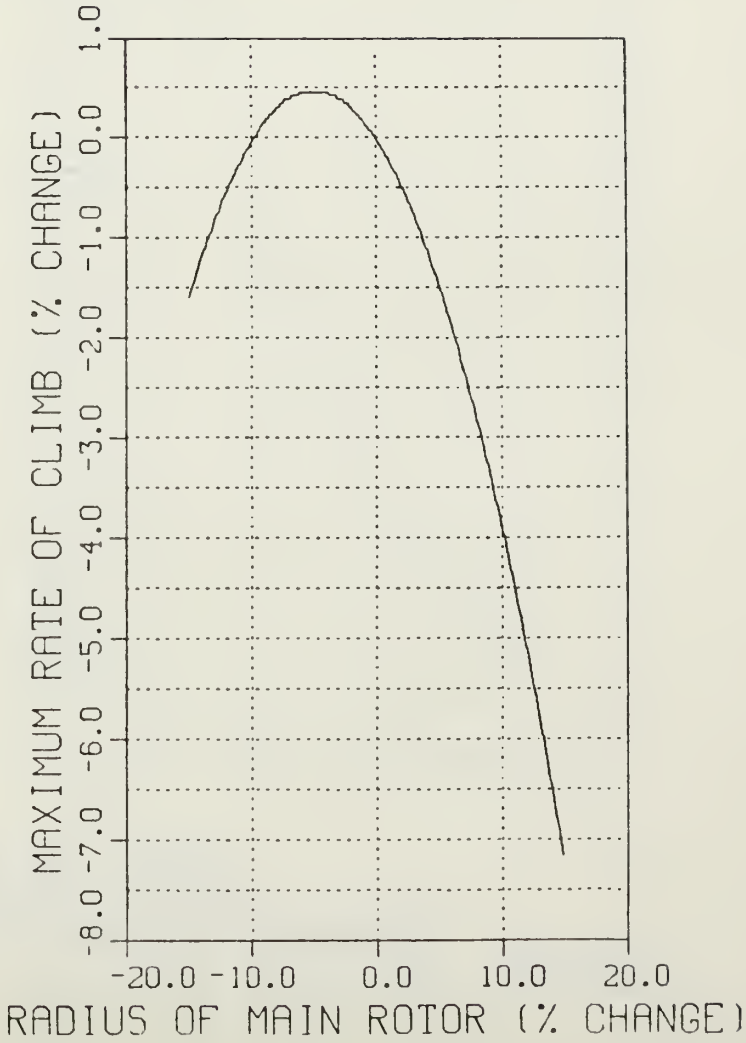
MAXIMUM RATE OF CLIMB VERSUS RADIUS CHANGE

CHORD, TIP VELOCITY & ADVANCE RATIO HELD CONSTANT
SOLIDITY, ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS

MAXIMUM RATE OF CLIMB VERSUS RADIUS CHANGE

CHORD & ROTATIONAL VELOCITY HELD CONSTANT
SOLIDITY, TIP VELOCITY & ADVANCE RATIO
ALLOWED TO VARY WITH RADIUS

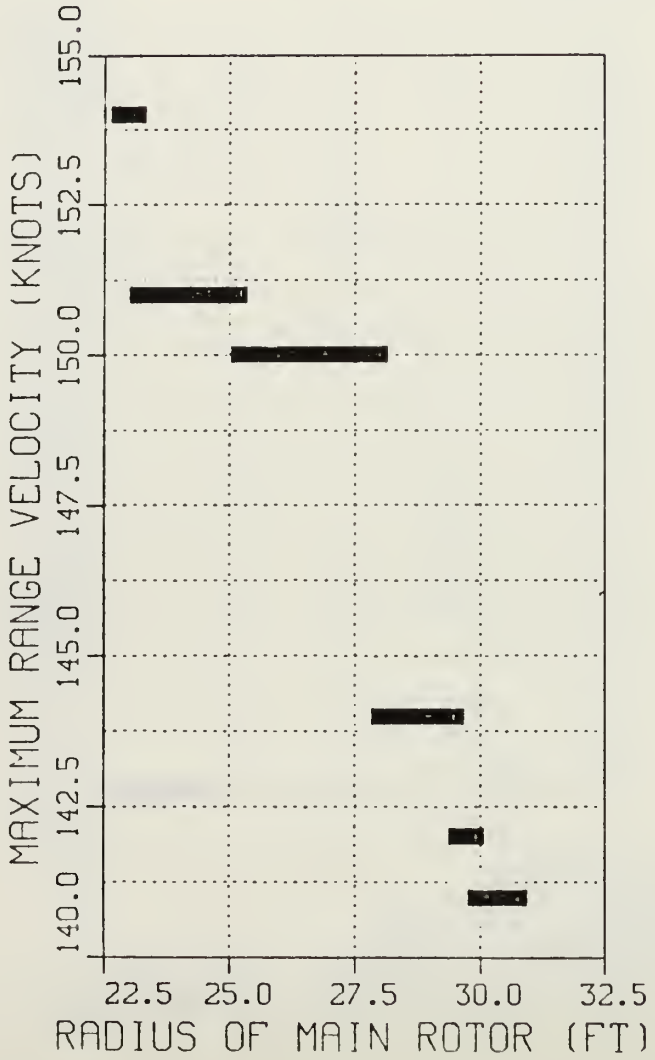


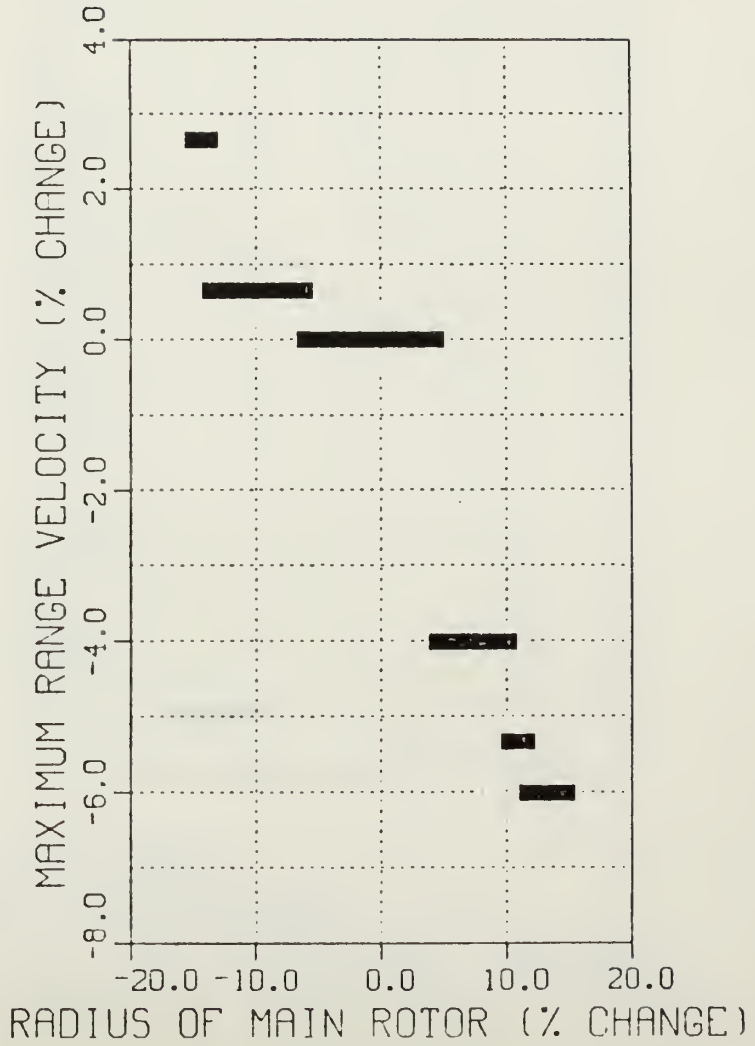


MAXIMUM RANGE VELOCITY VERSUS RADIUS CHANGE
CHORD & ROTATIONAL VELOCITY HELD CONSTANT
SOLIDITY, TIP VELOCITY & ADVANCE RATIO
ALLOWED TO VARY WITH RADIUS
MAXIMUM RANGE VELOCITY (KNOTS)
151.0
150.8
150.6
150.4
150.2
150.0
RADIUS OF MAIN ROTOR (FT)
22.5
25.0
27.5
30.0
32.5
MAXIMUM RANGE VELOCITY (% CHANGE)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
RADIUS OF MAIN ROTOR (% CHANGE)
-20.0
-10.0
0.0
10.0
20.0

MAXIMUM RANGE VELOCITY VERSUS RADIUS CHANGE

CHORD, TIP VELOCITY & ADVANCE RATIO HELD CONSTANT
SOLIDITY, ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS





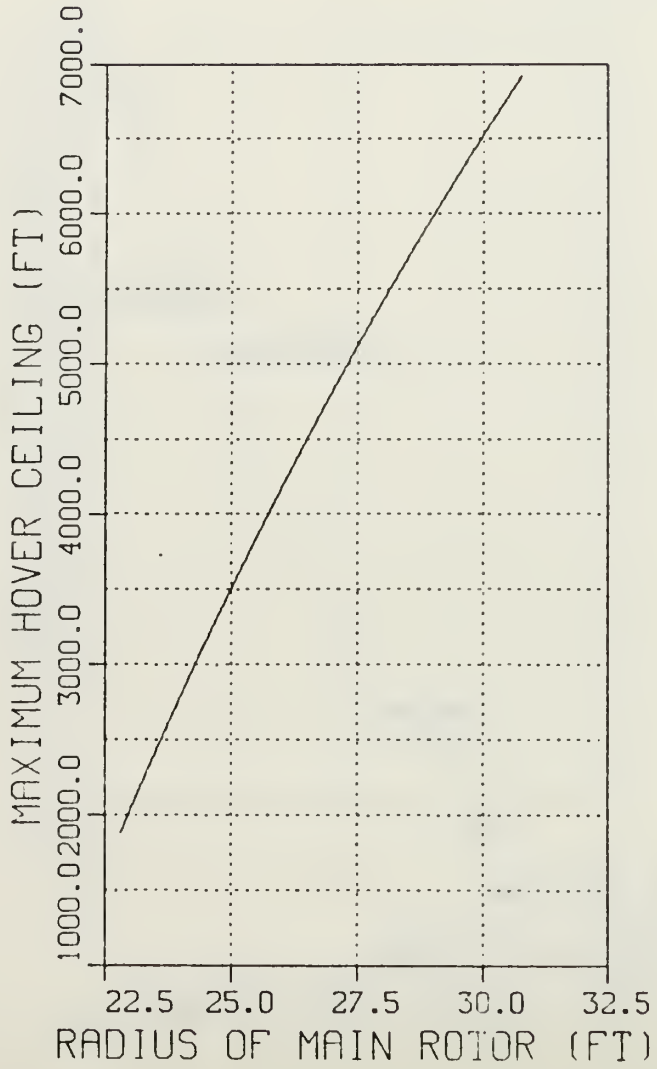
MAXIMUM RANGE VELOCITY VERSUS RADIUS CHANGE
SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT
CHORD,ADVANCE RATIO & TIP VELOCITY
ALLOWED TO VARY WITH RADIUS
MAXIMUM RANGE VELOCITY (KNOTS)
151.0
150.8
150.6
150.4
150.2
150.0
RADIUS OF MAIN ROTOR (FT)
22.5
25.0
27.5
30.0
32.5
MAXIMUM RANGE VELOCITY (% CHANGE)
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
RADIUS OF MAIN ROTOR (% CHANGE)
-20.0
-10.0
0.0
10.0
20.0

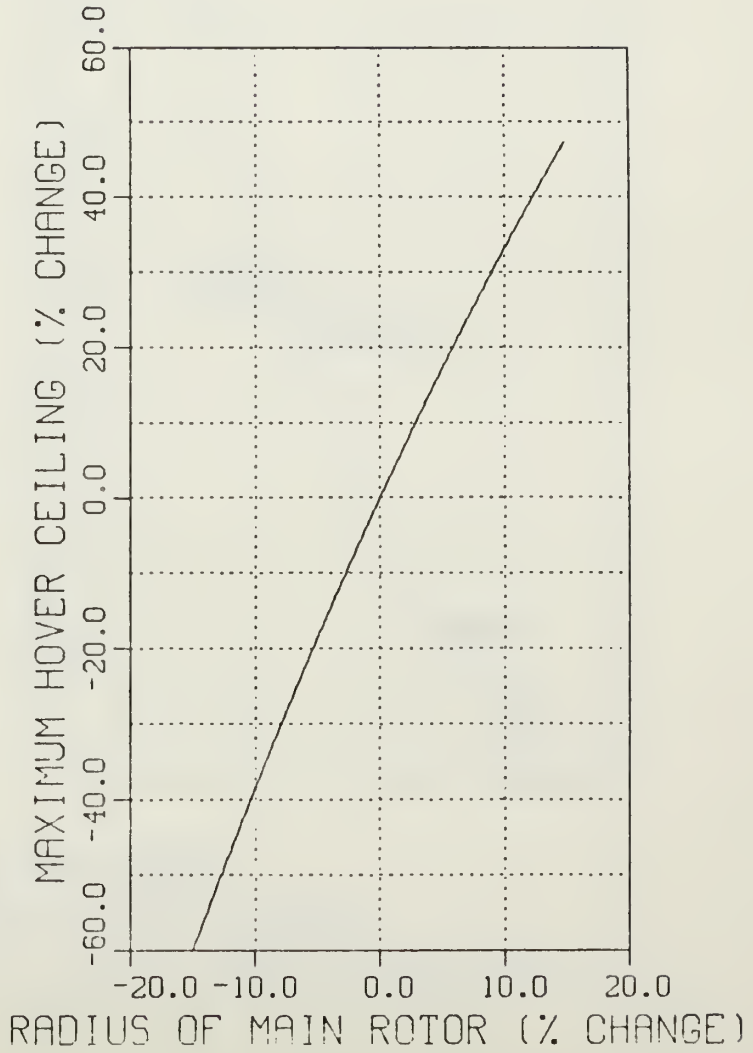
MAXIMUM RANGE VELOCITY VERSUS RADIUS CHANGE
SOLIDITY, ADVANCE RATIO & TIP VELOCITY HELD CONSTANT
CHORD & ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS
MAXIMUM RANGE VELOCITY (KNOTS)
155.0
152.5
150.0
147.5
145.0
142.5
140.0
22.5
25.0
27.5
30.0
32.5
RADIUS OF MAIN ROTOR (FT)
MAXIMUM RANGE VELOCITY (% CHANGE)
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-20.0
-10.0
0.0
10.0
20.0
RADIUS OF MAIN ROTOR (% CHANGE)

MAXIMUM HOVER CEILING (IGE) VERSUS RADIUS
CHORD & ROTATIONAL VELOCITY HELD CONSTANT
SOLIDITY, TIP VELOCITY & ADVANCE RATIO
ALLOWED TO VARY WITH RADIUS
MAXIMUM HOVER CEILING (FT)
2000.0 3500.0 4000.0 4500.0 5000.0 5500.0
22.5 25.0 27.5 30.0 32.5
RADIUS OF MAIN ROTOR (FT)
MAXIMUM HOVER CEILING (% CHANGE)
-50.0 -40.0 -30.0 -20.0 -10.0 0.0 10.0 20.0
-20.0 -10.0 0.0 10.0 20.0
RADIUS OF MAIN ROTOR (% CHANGE)

MAXIMUM HOVER CEILING (IGE) VERSUS RADIUS

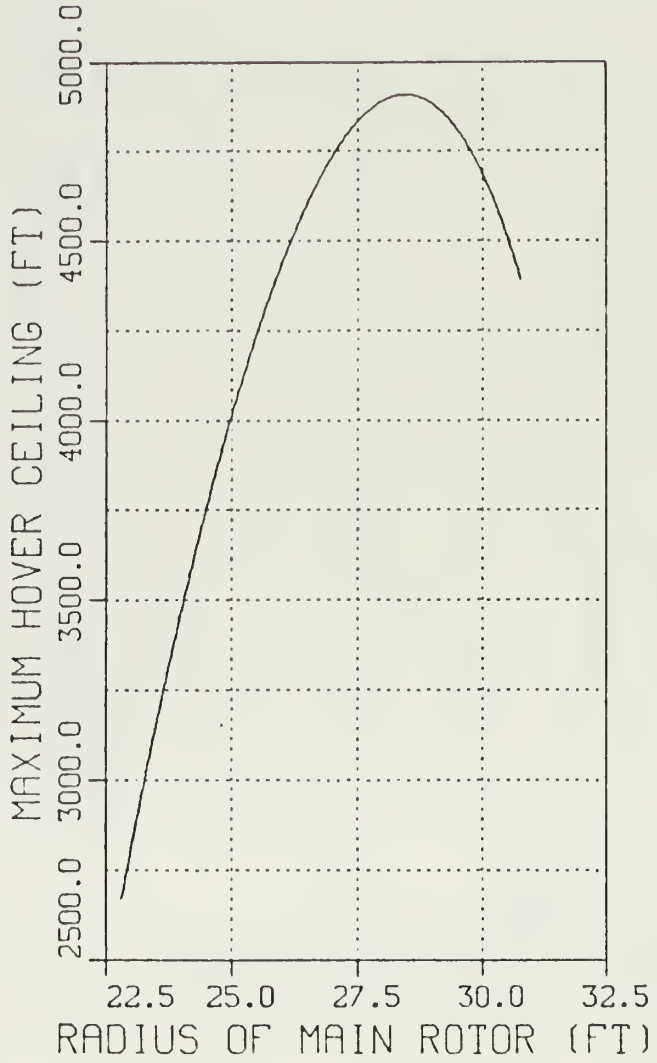
CHORD, TIP VELOCITY & ADVANCE RATIO HELD CONSTANT
SOLIDITY, ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS

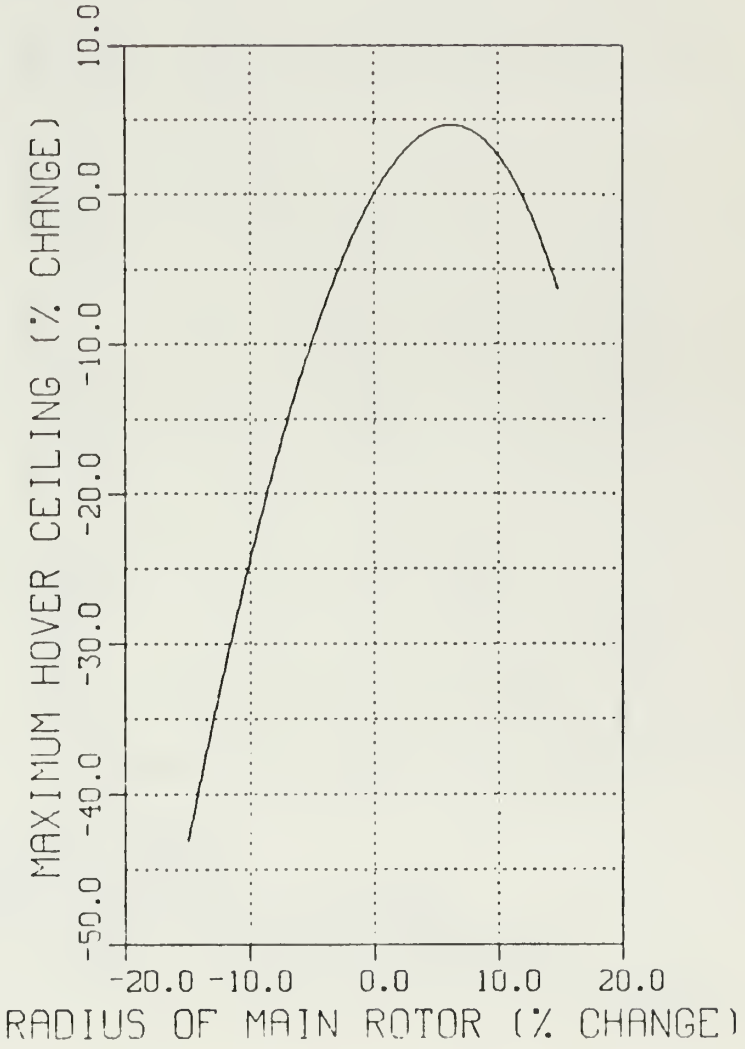




MAXIMUM HOVER CEILING (IGE) VERSUS RADIUS

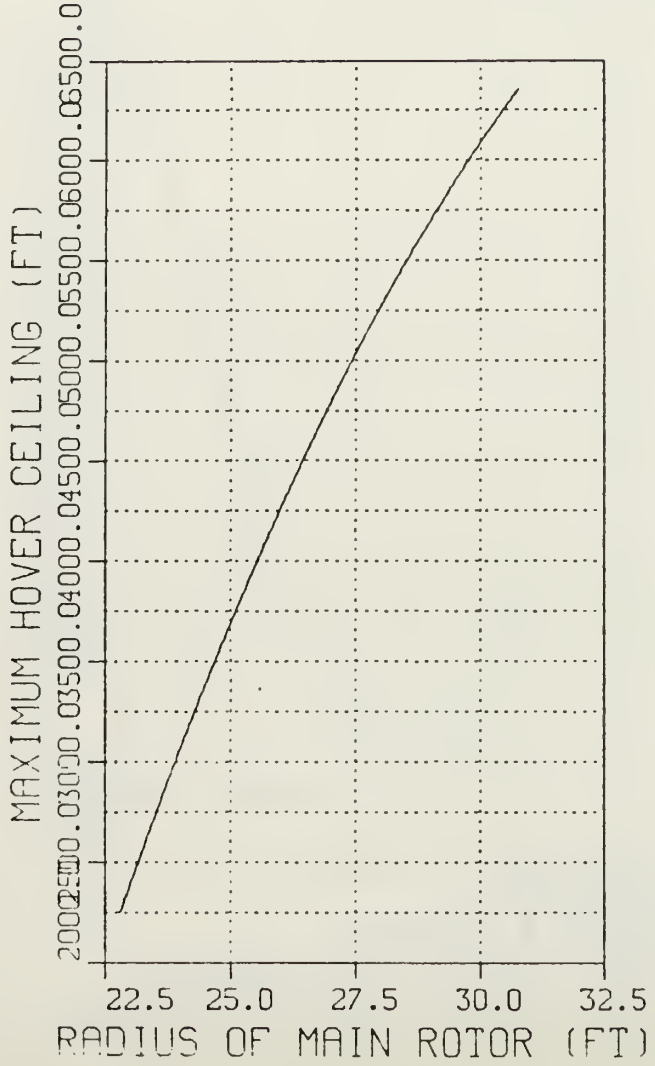
SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT
CHORD,ADVANCE RATIO & TIP VELOCITY
ALLOWED TO VARY WITH RADIUS

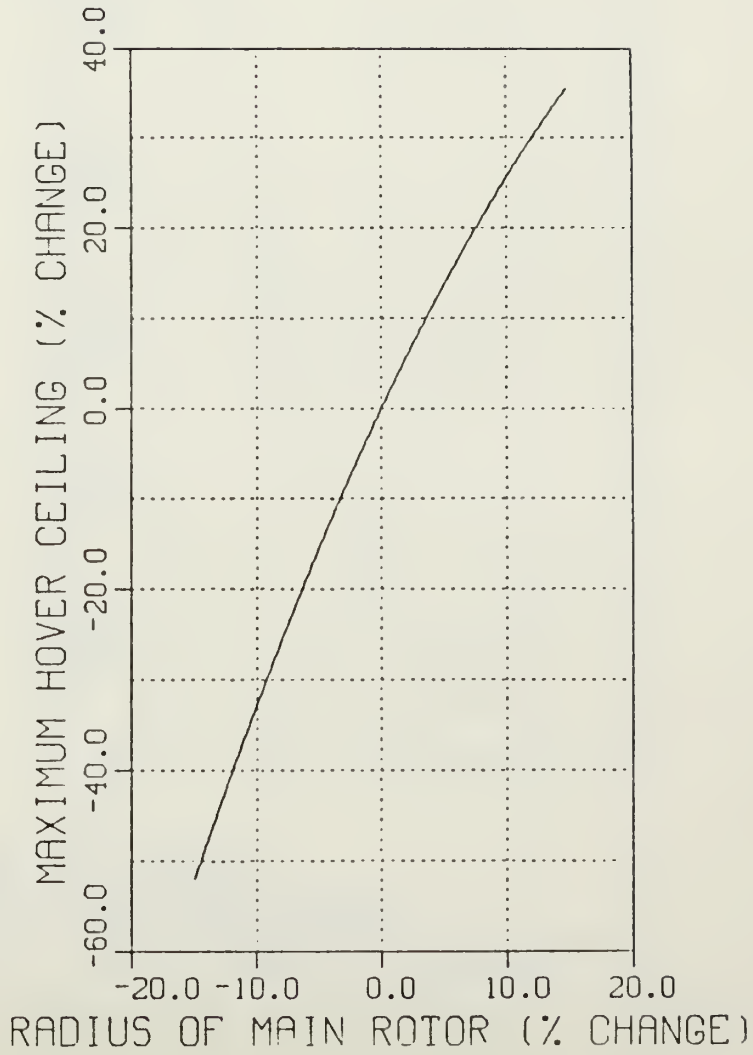




MAXIMUM HOVER CEILING (IGE) VERSUS RADIUS

SOLIDITY, ADVANCE RATIO & TIP VELOCITY HELD CONSTANT
CHORD & ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS



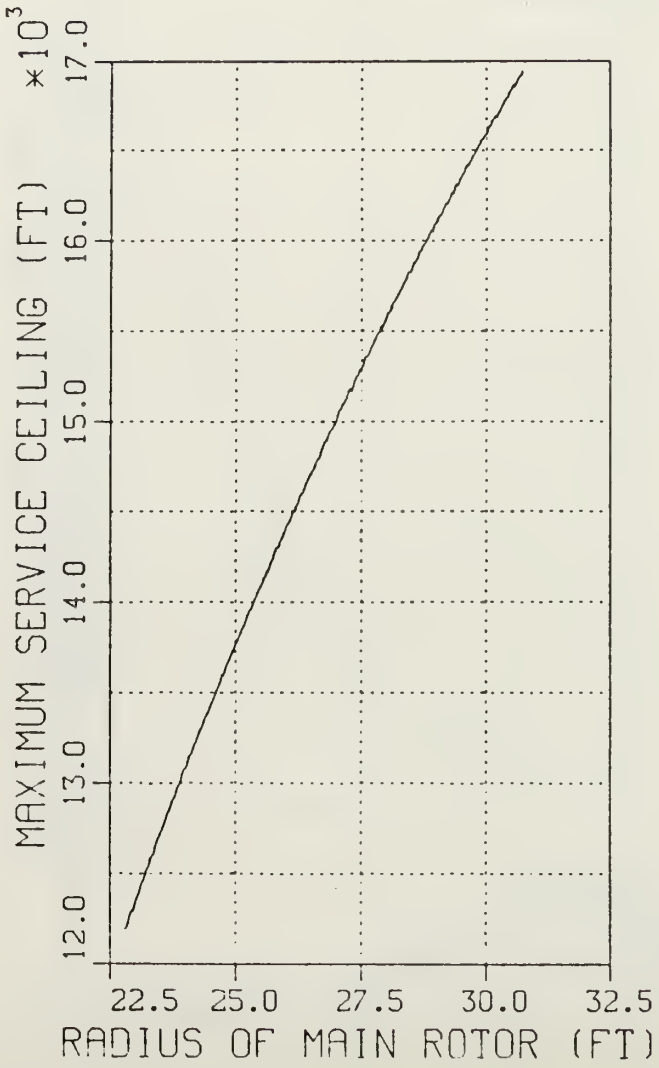


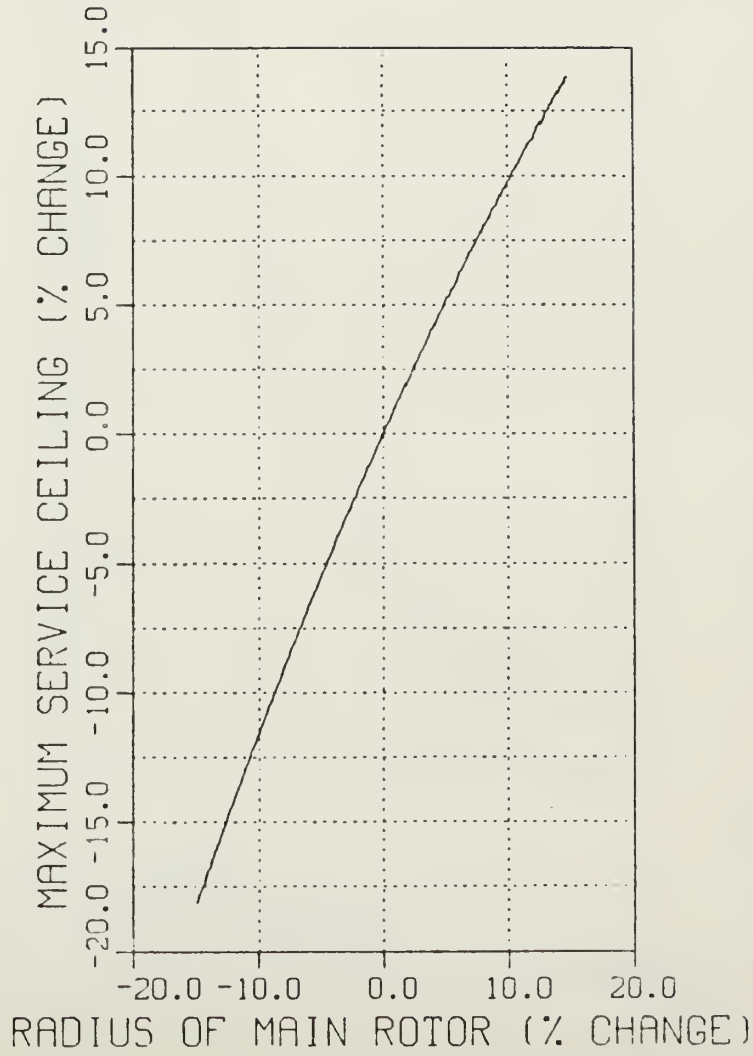
MAXIMUM SERVICE CEILING VERSUS RADIUS CHANGE

CHORD & ROTATIONAL VELOCITY HELD CONSTANT
SOLIDITY, TIP VELOCITY & ADVANCE RATIO
ALLOWED TO VARY WITH RADIUS

MAXIMUM SERVICE CEILING VERSUS RADIUS CHANGE

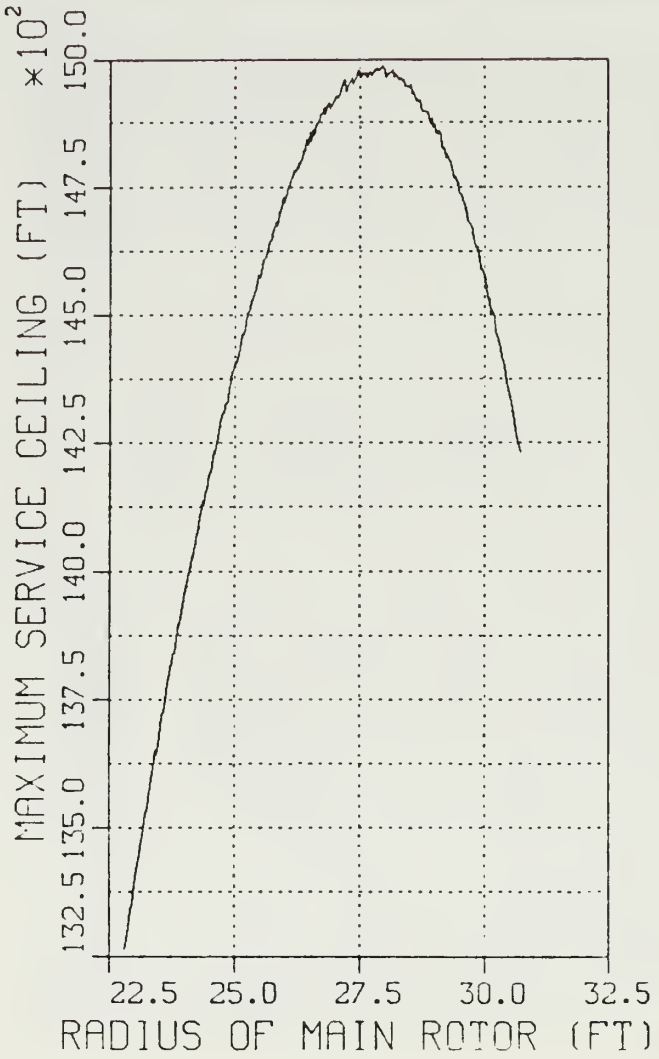
CHORD,TIP VELOCITY & ADVANCE RATIO HELD CONSTANT
SOLIDITY, ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS

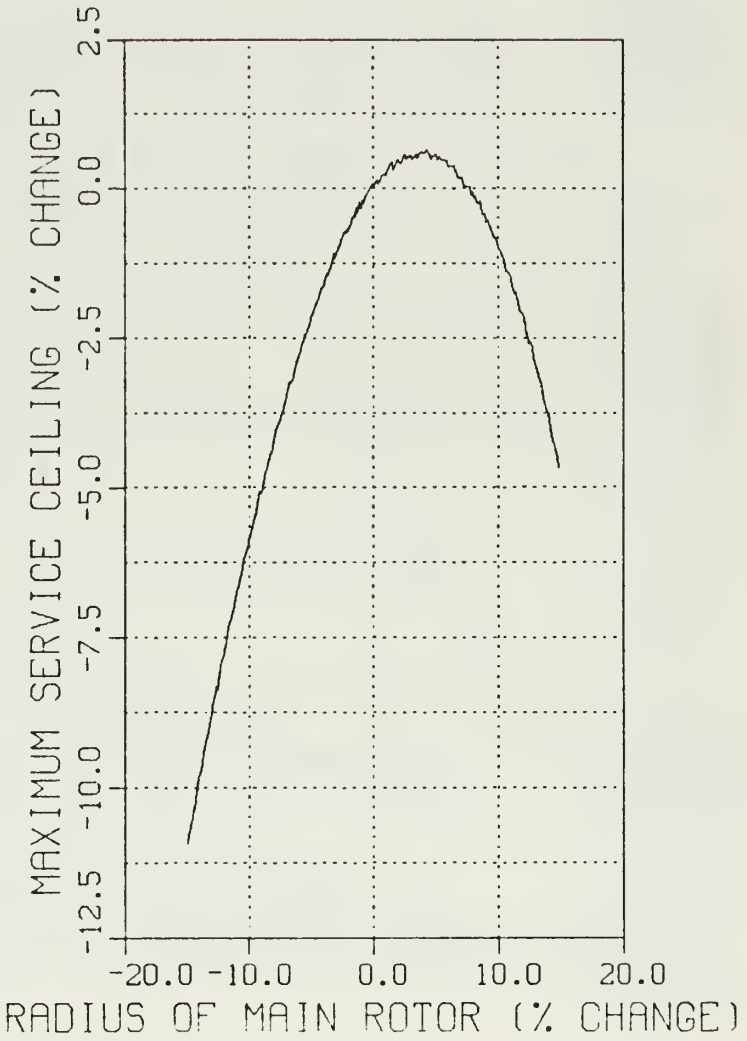




MAXIMUM SERVICE CEILING VERSUS RADIUS CHANGE

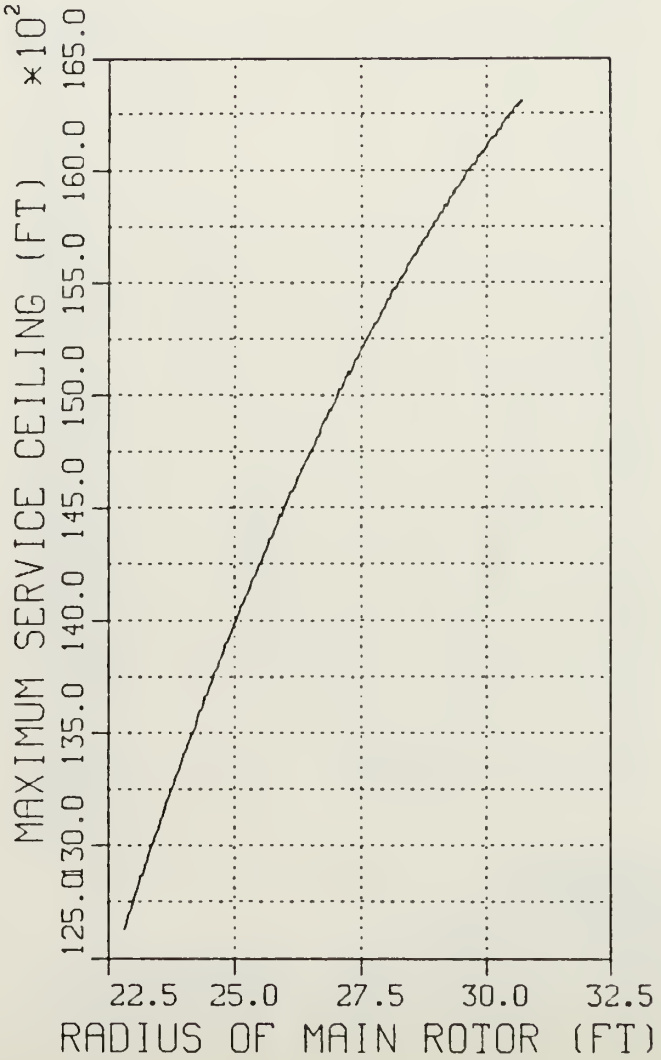
SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT
CHORD, ADVANCE RATIO & TIP VELOCITY
ALLOWED TO VARY WITH RADIUS

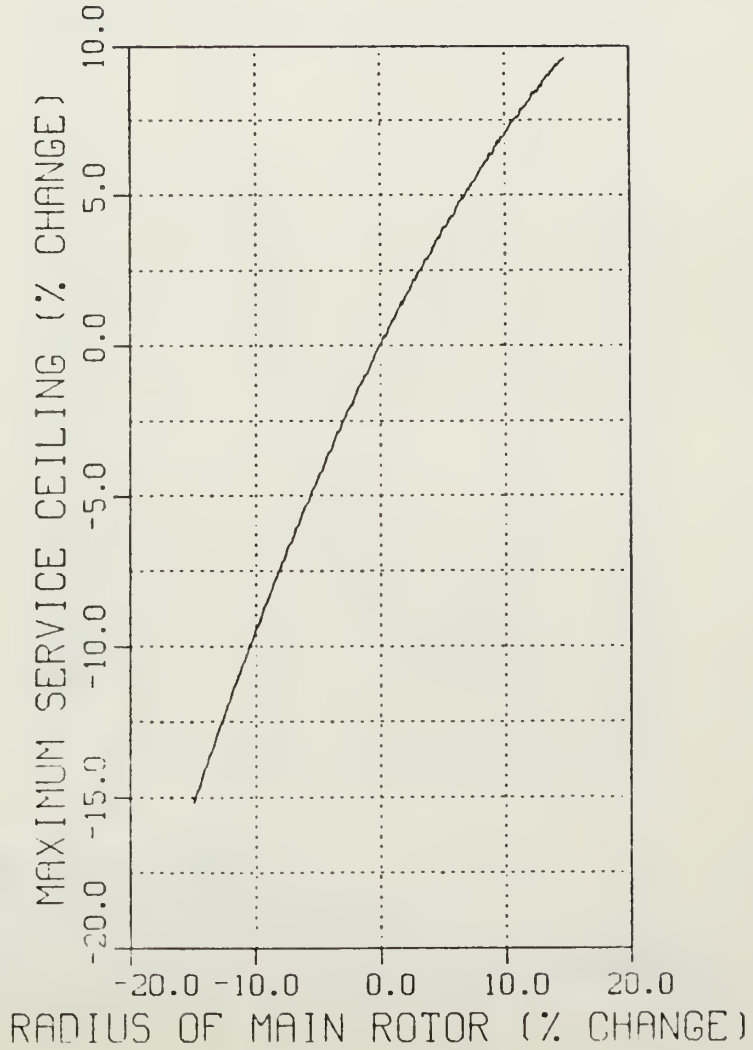




MAXIMUM SERVICE CEILING VERSUS RADIUS CHANGE

SOLIDITY, ADVANCE RATIO & TIP VELOCITY HELD CONSTANT
CHORD & ROTATIONAL VELOCITY
ALLOWED TO VARY WITH RADIUS





```
C                    PERFORMANCE DESIGN PROGRAM                          PEROCC10
C                                                                        PEROCC20
C                    COMPUTER PROGRAM LISTING                            PEROCC30
C                                                                        PEROCC40
C                                                                        PEROCC50
C*************************************************************          PEROCC60
C                                                                        PEROCC70
C        THIS PROGRAM WILL TAKE A SET OF HELICOPTER DESIGN DATA,         PEROCC80
C    CALCULATE POWER REQUIRED, ENDURANCE VELOCITY,RATE OF CLIMB, RANGE   PEROC090
C    VELOCITY, HOVER CEILING AND SERVICE CEILING FOR THAT DATA.  IT      PEROC100
C    ALSO WILL CALCULATE THE PERFORMANCE FACTORS LISTED ABOVE OVER A     PEROC110
C    RANGE OF VALUES FOR THE GIVEN DATA.  IT THEN WILL PLOT THE RESULTS
C    VERSUS MAIN ROTOR RADIUS IN TWO FORMS. FORM 1 BEING THE PERFORMANCE
C    FACTOR VALUE VERSUS THE MAIN ROTOR RADIUS.  FORM 2 BEING A
C    PERCENT DIFFERENCE OF THE PERFORMANCE VALUE FROM THE VALUE OF THE
C    FACTOR AT THE GIVEN SPECIFICATION VALUE VERSUS THE PERCENT
C    DIFFERENCE OF THE RADIUS TO THE SPECIFICATION RADIUS.
C
C-------------------------------------------------------------------
C    TO RUN THE PROGRAM FOLLOW THESE STEPS:
C
C    1.  INPUT THE REQUIRED DATA IN LINES  173-207
C    2.  COMPILE PROGRAM USING: FORTEX PERFORM ( NOMAP
C        NOTE: IF YOU DO NOT USE ( NOMAP, YOU WILL NOT HAVE ENOUGH DISK
C        SPACE TO RUN THE PROGRAM
C    3.  GRAPH PROGRAM USING: DISSPLA PERFORM
C    4.  EXAMINE RESULTS BY USING: DISSPCP
C
C-------------------------------------------------------------------
C  ***************   DEFINITION OF TERMS   ********************
C
C     AHAT - ZERO HORSEPOWER FUEL FLOW INTERCEPT
C     AMR - DISK AREA OF THE MAIN ROTOR (FT**2)
C     ARMR - ADVANCE RATIO OF THE MAIN ROTOR SYSTEM
C     ARTR - ADVANCE RATIO OF THE TAIL ROTOR SYSTEM
C     ATR - DISK AREA OF THE TAIL ROTOR (FT**2)
C     BHAT - AVERAGE SLOPE OF THE FUEL FLOW VS HORSEPOWER                PEROC370
C     CDCMR - AVERAGE COEFFICIENT OF DRAG OF THE MAIN ROTOR BLADES       PEROC380
C     CDCTR - AVERAGE COEFFICIENT OF DRAG OF THE TAIL ROTOR BLADES       PEROC390
C     CEIL - SUBROUTINE TO CALCULATE MAX SERVICE CEILING                 PEROC400
C     CMR,CMR1 - CHORD LENGHT OF MAIN ROTOR (FT)                         PEROC410
C     CONST - SUBROUTINE TO CALCULATE COMMON USED CONSTANTS              PEROC420
C     CTMR - COEFFICIENT OF THRUST OF THE MAIN ROTOR SYSTEM              PEROC430
C     CTR - CHORD LENGHT OF TAIL ROTOR (FT)                              PEROC440
C     CTTR - COEFFICIENT OF THRUST OF THE TAIL ROTOR SYSYTEM             PEROC450
C     D.... - USED TO INDICATE A DIFFERENCE IN A VARIABLE, SEE VARIABLE  PEROC460
C     DA - DENSITY ALTITUDE (FT)                                         PEROC470
C     DELTA - PRESSURE RATIO (ALTITUDE/SSL)                              PEROC480
```

```
C      DEN,DEN1 - DENSITY OF ATMOSPHERE (SLUGS/FT**3)                          PER00490
C      EFPAF - EFFECTIVE FLAT PLATE AREA - FORWARD (FT**2)                     PER00500
C      EFPAV - EFFECTIVE FLATE PLATE AREA - VERTICAL (FT**2)                   PER00510
C      ENDUR - SUBROUTINE TO CALCULATE ENDURANCE VELOCITY                      PER00520
C      ENGPOW - POWER AVAILABLE PER ENGINE (SHP)                               PER00530
C      FMERT - FIGURE OF MERIT                                                 PER00540
C      GE - GROUND EFFECT FACTOR                                               PER00550
C      HD - ROTOR HEIGHT TO ROTOR DIAMETER RATIO                               PER00560
C      HOVALT - ALTITUDE FOR MAX HOVER CEILING (FT)                            PER00570
C      HOVER - SUBROUTINE TO CALCULATE MAX HOVER CEILING                       PER00580
C      IANS - PERFORMANCE FACTOR BEING CALCULATED                              PER00590
C      IBMR - NUMBER OF BLADES OF THE MAIN ROTOR SYSTEM                        PER00600
C      IBTR - NUMBER OF BLADES OF THE TAIL ROTOR SYSTEM                        PER00610
C      IENG - NUMBER OF ENGINES                                                PER00620
C      L - LENGTH OF TAIL BOOM (FT)                                            PER00630
C      MAX... - MAXIMUM VALUE FOR X OR Y AXIS                                  PER00640
C      MAXRC - SUBROUTINE TO CALCULATE MAX RATE OF CLIMB                       PER00650
C      MIN... - MINIMUM VALUE FOR X OR Y AXIS                                  PER00660
C      PA, PRESS1 - PRESSURE ALTITIDE (FT)                                     PER00670
C      PIMR - INDUCED POWER OF THE MAIN ROTOR WITH TIP LOSS & GROUND           PER00680
C             EFFECT (SHP)                                                     PER00690
C      PITR - INDUCED POWER OF THE TAIL ROTOR WITH TIP LOSS (SHP)              PER00700
C      PCMR - CLIMB POWER OF THE MAIN ROTOR (SHP)                              PER00710
C      PSHP - PHANTOM SHAFT HORSEPOWER (SHP)                                   PER00720
C      POMR - PROFILE POWER OF THE MAIN ROTOR (SHP)                            PER00730
C      POTR - PROFILE POWER OF THE TAIL ROTOR (SHP)                            PER00740
C      POWER - SUBROUTINE TO CALCULATE POWER REQUIREMENTS                      PER00750
C      POWMR - SUBROUTINE TO CALCULATE POWER REQUIREMENTS FOR MAIN ROTOR       PER00760
C      POWTR - SUBROUTINE TO CALCULATE POWER REQUIREMENTS FOR TAIL ROTOR       PER00770
C      PPMR - PARASITE POWER OF THE MAIN ROTOR (SHP)                           PER00780
C      POWAA - POWER AVAILABLE AT ALTITUDE (SHP)                               PER00790
C      PTAC - TOTAL POWER OF THE AIRCRAFT (SHP)                                PER00800
C      PTAVAL - POWER AVAILABLE FOR AIRCRAFT                                   PER00810
C      PTMIN - MINIMUM POWER REQUIRED FOR MAXIMUM ENDURANCE                    PER00820
C      PTMR - TOTAL POWER OF THE MAIN ROTOR (SHP)                              PER00830
C      PTTR - TOTAL POWER OF THE TAIL ROTOR (SHP)                              PER00840
C      RANGE - SUBROUTINE TO CALCULATE THE MAX RANGE VELOCITY                  PER00850
C      RCMAX,RCMAXX - MAXIMUM RATE OF CLIMB (FT/MIN)                           PER00860
C      RHO - SUBROUTINE TO CALCULATE DENSITY                                   PER00870
C      RMR,RRMR - RADIUS OF THE MAIN ROTOR (FT)                                PER00880
C      RTR - RADIUS OF THE TAIL ROTOR (FT)                                     PER00890
C      RTHT - MAIN ROTOR HEIGHT ABOVE THE SKIDS OR WHEELS (FT)                 PER00900
C      RVMR,RVMR1 - ROTATIONAL VELOCITY OF THE MAIN ROTOR (RAD/SEC)            PER00910
C      RVTR - ROTATIONAL VELOCITY OF THE TAIL ROTOR (RAD/SEC)                  PER00920
C      SOMR,SOMR3 - SOLIDITY OF THE MAIN ROTOR                                 PER00930
C      SOTR - SOLITITY OF THE TAIL ROTOR                                       PER00940
C      SEV,SEVALT - ALTITUDE FOR SERVICE CEILING (FT)                          PER00950
C      SFCM,SFCN,SFCC- SPECIFIC FUEL CONSUMPTION MILITARY,NORMAL,CRUISE        PER00960
```

```
C      SHPM,SHPN,SHPC - SHAFT HORSEPOWER (SSL) MILITARY,NORMAL,CRUISE     PER00970
C      SHPRAN - SHAFT HORSEPOWER REQUIRED AT RANGE VELOCITY (SHP)         PER00980
C      SKDHT - SKID OR WHEEL HEIGHT ABOVE THE THE GROUND (FT)             PER00990
C      TEMP,TEMP1 - TEMPERATURE (DEGREES F)                               PER01000
C      THETA - TEMPERATURE RATIO (ALTITUDE/SSL)                           PER01010
C      TLMR - TIP LOSS FACTOR OF THE MAIN ROTOR                           PER01020
C      TLTR - TIP LOSS FACTOR OF THE TAIL ROTOR                           PER01030
C      TTR - THRUST OF THE TAIL ROTOR (LBS FORCE)                         PER01040
C      VELMR - SUBROUTINE TO CALCULATE INDUCED VELOCITY FOR MAIN ROTOR    PER01050
C      VELTR - SUBROUTINE TO CALCULATE INDUCED VELOCITY FOR TAIL ROTOR    PER01060
C      VF,VFF,VF1 - FORWARD VELOCITY (KNOTS)                              PER01070
C      VFEND - VELOCITY FOR MAXIMUM ENDURANCE                             PER01080
C      VFRAN - RANGE VELOCITY (KTS)                                       PER01090
C      VV - VERTICAL VELOCITY (FT/MIN)                                    PER01100
C      VIHMR - INDUCED VELOCITY OF MAIN ROTOR AT A HOVER (FT/SEC)         PER01110
C      VIHTR - INDUCED VELOCITY OF TAIL ROTOR AT A HOVER (FT/SEC)         PER01120
C      VIMR - INDUCED VELOCITY OF MAIN ROTOR (FT/SEC)                     PER01130
C      VITR - INDUCED VELOCITY OF TAIL ROTOR (FT/SEC)                     PER01140
C      VITMR - INDUCED VELOCITY OF MAIN ROTOR IN FORWARD FLIGHT (FT/SEC)  PER01150
C      VITTR - INDUCED VELOCITY OF TAIL ROTOR IN FORWARD FLIGHT (FT/SEC)  PER01160
C      VIVMR - INDUCED VELOCITY OF MAIN ROTOR IN VERTICAL FLIGHT (FT/SEC)PER01170
C      VTMR, VTMR2 - TIP VELOCITY OF MAIN ROTOR (FT/SEC)                  PER01180
C      W - TOTAL WEIGHT OF THE HELICOPTER (LBS)                           PER01190
C      WDE,RANMAX - RATIO OF WEIGHT AND DRAG                              PER01200
C      WFM,WFN,WFC - FUEL FLOW RATE                                       PER01210
C                                                                         PER01220
C  ***********************************************************************PER01230
C  ***********************************************************************PER01240
C***********************************************************************  PER01250
       IMPLICIT REAL (A-H,L-Z)                                            PER01260
       COMMON /W/ RCMAX(400),DRCMAX(400),VFRAN(400),DVFRAN(400),          PER01270
      * HOVALT(400),DHOVAL(400),SEVALT(400),DSEVAL(400),FMERT(400),      PER01280
      * DFMERT(400),VFEND(400),DVFEND(400)                               PER01290
       COMMON /A/ AMR,ARMR,ARTR,ATR,CDOMR,CDOTR,CMR,CTMR,CTR,CTTR,        PER01300
      * DA,DEN,EFPAF,EFPAV,GE,HD,L,PA,RADIUS,RTR,RTHT,RVMR,RVTR,SDMR,     PER01310
      * SDTR,SKDHT,TEMP,W,VF,VV,IBTR,IBMR,DENSSL,PIE,PTMIN(400),VIMR,     PER01320
      * VITR,VTTR,VTMR,RANMAX,THETA,DELTA,SHPRAN(400),VV1,VF1,IENG,SDMR3,PER01330
      * VTMR2,DIFF,SFCM,SFCN,SFCC,SHPM,SHPN,SHPC,CMR1,RVMR1,RRMR         PER01340
       COMMON /B/ PIMR(400),PDMR(400),PPMR(400),PCMR(400),PITR(400),      PER01350
      * PCTR(400),PTMR(400),PTTR(400),PTAC(400)                          PER01360
       COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,     PER01370
      * MAXZ,CMIN,CMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS,TEXT(200)   PER01380
       COMMON /Y/DPIMR(400),DPDMR(400),DPPMR(400),DPCMR(400),DPTMR(400),PER01390
      * DPITR(400),DPDTR(400),DPTAC(400),DPTTR(400)                      PER01400
       COMMON /Z/ VFEND1(400),VFEND2(400),VFEND3(400),VFEND4(400)        PER01410
C-----------------------------------------------------------------------  PER01420
 5     CALL FRTCMS('CLRSCRN ')                                           PER01430
       WRITE(5,6000)                                                     PER01440
```

```
      WRITE(5,6001)                                                     PER01450
      WRITE(5,6002)                                                     PER01460
      WRITE(5,6003)                                                     PER01470
      WRITE(5,6004)                                                     PER01480
      WRITE(5,6005)                                                     PER01490
      WRITE(5,6006)                                                     PER01500
      WRITE(5,6007)                                                     PER01510
      WRITE(5,6008)                                                     PER01520
      WRITE(5,6009)                                                     PER01530
      CALL RDINT(IANS)                                                  PER01540
      CALL FRTCMS('CLRSCRN ')                                           PER01550
      IF(IANS .EQ. 3 .OR. IANS .EQ. 6) WRITE (5,6010)                   PER01560
      WRITE(5,6011)                                                     PER01570
 6000 FORMAT(10X,'YOU MAY CHOOSE ANY OF THE FOLLOWING PERFORMANCE ')    PER01580
 6001 FORMAT(10X,'FACTORS TO EXAMINE.  EACH ONE COULD TAKE 2-5 MINUTES')PER01590
 6002 FORMAT(10X,'TO RUN (ON AN AVERAGE). ',//)                         PER01600
 6003 FORMAT(15X,'1.  POWER REQUIREMENTS')                              PER01610
 6004 FORMAT(15X,'2.  MAXIMUM ENDURANCE VELOCITY')                      PER01620
 6005 FORMAT(15X,'3.  MAXIMUM RATE OF CLIMB')                           PER01630
 6006 FORMAT(15X,'4.  MAXIMUM RANGE VELOCITY')                          PER01640
 6007 FORMAT(15X,'5.  MAXIMUM HOVER CEILING (IGE)')                     PER01650
 6008 FORMAT(15X,'6.  MAXIMUM SERVICE CEILING')                         PER01660
 6009 FORMAT(10X,//,'ENTER THE NUMBER (1,2,3,4,5,OR 6) YOU WISH TO EXAMIPER01670
     *NE')                                                              PER01680
 6010 FORMAT(5X,'THIS MAY TAKE SOME TIME IF THERE ARE ALOT OF USERS')   PER01690
 6011 FORMAT(5X,'CALCULATING RESULTS')                                  PER01700
C*************************************************************        PER01710
C                                                                       PER01720
C##########  INPUT DATA FOR HELICOPTER TO BE EXAMINED  ##########      PER01730
C                                                                       PER01740
C*************************************************************        PER01750
C---------------------- INPUT MAIN ROTOR DATA ----------------------    PER01760
      RADIUS = 26.8                                                     PER01770
C---------------------- +/- VALUE FROM SPEC RADIUS       -----------    PER01780
      DIFF = 4.0                                                        PER01790
      CMR1 = 1.75                                                       PER01800
      RVMR1 = 27.0                                                      PER01810
      CDOMR = 0.008                                                     PER01820
      IBMR = 4                                                          PER01830
C---------------------- INPUT TAIL ROTOR DATA ----------------------    PER01840
      RTR = 5.5                                                         PER01850
      CTR = 0.81                                                        PER01860
      RVTR = 124.6                                                      PER01870
      CDOTR = 0.008                                                     PER01880
      IBTR = 4                                                          PER01890
C---------------------- INPUT GENERAL AIRFRAME DATA ----------------    PER01900
      L = 31.5                                                          PER01910
      W = 20000.0                                                       PER01920
```

```
      EFPAF = 25.7                                                          PER01930
      EFPAV = 31.8                                                          PER01940
      RTHT = 11.2                                                           PER01950
C---------------------- INPUT ENGINE DATA ----------------------------     PER01960
      IENG = 2                                                              PER01970
      SFCM = 0.46                                                           PER01980
      SFCN = 0.47                                                           PER01990
      SFCC = 0.51                                                           PER02000
      SHPM = 1561.0                                                         PER02010
      SHPN = 1318.0                                                         PER02020
      SHPC = 989.0                                                          PER02030
C------------- INPUT FLIGHT VELOCITY FOR INITIAL POWER CALCULATIONS ---     PER02040
      VF1 = 90.0                                                            PER02050
C=========    END OF REQUIRED INPUT INFORMATION  ======================    PER02060
C=================================================================        PER02070
      DO 3000 K = 1,4                                                       PER02080
      VV1 = 0.0                                                             PER02090
      PA = 0.0                                                              PER02100
      TEMP = 0.0                                                            PER02110
      DA = 0.0                                                              PER02120
      DENSSL = 0.00237694                                                   PER02130
      SKDHT = 2500.0                                                        PER02140
      VF = VF1                                                              PER02150
      VV = VV1                                                              PER02160
      CMR = CMR1                                                            PER02170
      RVMR = RVMR1                                                          PER02180
      PIE = 3.141593                                                        PER02190
      SDMR3 = IBMR*CMR1 / (PIE*RADIUS)                                      PER02200
      VTMR2 = RVMR1*RADIUS                                                  PER02210
      CALL RHO                                                              PER02220
      CALL RAD(DIFF,RADIUS,RRMR,RMR,DRMR,MINZ,MAXZ,DMIN,DMAX)               PER02230
      IF(IANS .NE. 1) GO TO 2800                                            PER02240
      CALL POWER                                                            PER02250
      GO TO 3000                                                            PER02260
2800  IF(IANS .NE. 2) GO TO 2810                                            PER02270
      CALL ENDUR                                                            PER02280
      GO TO 3000                                                            PER02290
2810  IF(IANS .NE. 3) GO TO 2820                                            PER02300
      CALL ENDUR                                                            PER02310
      CALL MAXRC                                                            PER02320
      GO TO 3000                                                            PER02330
2820  IF(IANS .NE. 4) GO TO 2830                                            PER02340
      CALL RANGE                                                            PER02350
      GO TO 3000                                                            PER02360
2830  IF(IANS .NE. 5) GO TO 2840                                            PER02370
      CALL HOVER                                                            PER02380
      GO TO 3000                                                            PER02390
2840  IF(IANS .NE. 6) GO TO 2850                                            PER02400
```

```
      CALL ENDUR                                                        PERO2410
      CALL CEIL                                                         PERO2420
      GO TO 3000                                                        PERO2430
2850  GO TO 5                                                           PERO2440
3000  CONTINUE                                                          PERO2450
      CALL DONEPL                                                       PERO2460
5000  CONTINUE                                                          PERO2470
      STOP                                                              PERO2480
      END                                                               PERO2490
C*****************************************************************     PERO2500
C                                                                       PERO2510
C                  SUBROUTINES USED IN PRGRAM FOLLOW                    PERO2520
C                                                                       PERO2530
C*****************************************************************     PERO2540
C*****************************************************************     PERO2550
      SUBROUTINE RAD(DIFF,RADIUS,RRMR,RMR,DRMR,MINZ,MAXZ,DMIN,DMAX)     PERO2560
      IMPLICIT REAL (A-H,L-Z)                                           PERO2570
      DIMENSION RMR(400),DRMR(400)                                      PERO2580
      RRMR = RADIUS - DIFF                                              PERO2590
      DO 10 I = 1,324                                                   PERO2600
         RMR(I) = RRMR                                                  PERO2610
         IF (I .EQ. 163) RMR(I) = RADIUS                                PERO2620
         RRMR = RRMR + DIFF/162                                         PERO2630
 10   CONTINUE                                                          PERO2640
      DO 20 I = 1,324                                                   PERO2650
         DRMR(I) = ((RMR(I) - RMR(163)) / RMR(163)) * 100.0             PERO2660
 20   CONTINUE                                                          PERO2670
      DMIN = DRMR(1)                                                    PERO2680
      DMAX = DRMR(324)                                                  PERO2690
      MINZ = RMR(1)                                                     PERO2700
      MAXZ = RMR(324)                                                   PERO2710
      RETURN                                                            PERO2720
      END                                                               PERO2730
C=================================================================      PERO2740
C============                                    ==========           PERO2750
C=============          SUB-GROUP B          ==========               PERO2760
C============      PERFORMANCE SUBROUTINES      ==========             PERO2770
C=============                                  ==========             PERO2780
C=================================================================     PERO2790
C*****************************************************************     PERO2800
C                                                                       PERO2810
C  SUBROUTINE TO CALCULATE ALL PARTS OF THE TOTAL POWER REQUIREMENTS     PERO2820
C        AND FIGURE OF MERIT.                                           PERO2830
C                                                                       PERO2840
C*****************************************************************     PERO2850
C*****************************************************************     PERO2860
      SUBROUTINE POWER                                                  PERO2870
      IMPLICIT REAL (A-H,L-Z)                                           PERO2880
```

```
      INTEGER I,J,K                                                          PER02890
      COMMON /A/ AMR,ARMR,ARTR,ATR,CDOMR,CDOTR,CMR,CTMR,CTR,CTTR,            PER02900
     * DA,DEN,EFPAF,EFPAV,GE,HD,L,PA,RADILS,RTR,RTHT,RVMR,RVTR,SDMR,        PER02910
     * SCTR,SKCHT,TEMP,W,VF,VV,IBTR,IBMR,DENSSL,PIE,PTMIN(400),VIMR,        PER02920
     * VITR,VTTR,VTMR,RANMAX,THETA,DELTA,SHPRAN(400),VV1,VF1,IENG,SDMR3,    PER02930
     * VTMR2,DIFF,SFCM,SFCN,SFCC,SHPM,SHPN,SHPC,CMR1,RVMR1,RRMR             PER02940
      COMMON /B/ PIMR(400),PCMR(400),PPMR(400),PCMR(400),PITR(400),         PER02950
     * POTR(400),PTMR(400),PTTR(400),PTAC(400)                             PER02960
      COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,        PER02970
     * MAXZ,DMIN,DMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS,TEXT(200)      PER02980
      COMMON /H/ RCMAX(400),DRCMAX(400),VFRAN(400),DVFRAN(400),             PER02990
     * HOVALT(400),DHOVAL(400),SEVALT(400),DSEVAL(400),FMERT(400),         PER03000
     * DFMERT(400),VFEND(400),DVFEND(400)                                   PER03010
      COMMON /Y/DPIMR(400),DPOMR(400),DPPMR(400),DPCMR(400),DPTMR(400),PER03020
     * DPITR(400),DPOTR(400),DPTAC(400),DPTTR(400)                         PER03030
C-------------------------------------------------------------------------PER03040
      MAX = 0.0                                                             PER03050
      MAXA = 0.0                                                            PER03060
      DO 40 I = 1,324                                                       PER03070
         CALL CONST                                                         PER03080
         AMR = RMR(I)**2.0*PIE                                              PER03090
         IF(K .NE.1) GO TO 8                                                PER03100
              VTMR = RVMR*RMR(I)                                            PER03110
              ARMR = VF / (RVMR*RMR(I))                                     PER03120
              SDMR = IBMR*CMR / (PIE*RMR(I))                                PER03130
8        IF(K .NE. 2) GO TO 10                                              PER03140
              RVMR = VTMR2/RMR(I)                                           PER03150
              VTMR = RVMR*RMR(I)                                            PER03160
              ARMR = VF / (RVMR*RMR(I))                                     PER03170
              SDMR = IBMR*CMR1 / (PIE*RMR(I))                               PER03180
10       IF(K .NE. 3) GO TO 12                                              PER03190
              CMR = SDMR3*PIE*RMR(I)/IBMR                                   PER03200
              SDMR = IBMR*CMR / (PIE*RMR(I))                                PER03210
              RVMR = RVMR1                                                  PER03220
              ARMR = VF / (RVMR*RMR(I))                                     PER03230
              VTMR = RVMR*RMR(I)                                            PER03240
12       IF(K .NE. 4) GO TO 14                                              PER03250
              CMR = SDMR3*PIE*RMR(I)/IBMR                                   PER03260
              SDMR = IBMR*CMR / (PIE*RMR(I))                                PER03270
              RVMR = VTMR2/RMR(I)                                           PER03280
              VTMR = RVMR*RMR(I)                                            PER03290
              ARMR = VF / (RVMR*RMR(I))                                     PER03300
14       CALL VELMR                                                         PER03310
         CALL PCWMR                                                         PER03320
         CALL VELTR                                                         PER03330
         CALL PCWTR                                                         PER03340
         IF(PIMR(I) .GT. MAXA) MAXA = PIMR(I)                               PER03350
         IF(PCMR(I) .GT. MAXA) MAXA = POMR(I)                               PER03360
```

```
          IF(PPMR(I) .GT. MAXA) MAXA = PPMR(I)                          PER03370
          IF(VV .LE. 0.0 ) GO TO 20                                     PER03380
          IF(PCMR(I) .GT. MAXA) MAXA = PCMR(I)                          PER03390
20        IF(PTAC(I) .GT. MAX) MAX = PTAC(I)                            PER03400
          VF = VF / 1.68885                                             PER03410
          VV = VV * 60.0                                                PER03420
40    CONTINUE                                                          PER03430
C-------------------------------------------------------------------    PER03440
      MINY = 500.0                                                      PER03450
      MAXY = -500.0                                                     PER03460
      MINX = 500.0                                                      PER03470
      MAXX = -500.0                                                     PER03480
      DO 140 I = 1,324                                                  PER03490
         DPIMR(I) = ((PIMR(I) - PIMR(163)) / PIMR(163)) * 100.0         PER03500
           IF(DPIMR(I) .GT. MAXX) MAXX = DPIMR(I)                       PER03510
           IF(DPIMR(I) .LT. MINX) MINX = DPIMR(I)                       PER03520
         DPOMR(I) = ((POMR(I) - POMR(163)) / POMR(163)) * 100.0         PER03530
           IF(DPOMR(I) .GT. MAXX) MAXX = DPOMR(I)                       PER03540
           IF(DPOMR(I) .LT. MINX) MINX = DPOMR(I)                       PER03550
         DPPMR(I) = ((PPMR(I) - PPMR(163)) / PPMR(163)) * 100.0         PER03560
           IF(DPPMR(I) .GT. MAXX) MAXX = DPPMR(I)                       PER03570
           IF(DPPMR(I) .LT. MINX) MINX = DPPMR(I)                       PER03580
         IF(VV .LE. 0.0 ) GO TO 120                                     PER03590
         DPCMR(I) = ((PCMR(I) - PCMR(163)) / PCMR(163)) * 100.0         PER03600
           IF(DPCMR(I) .GT. MAXX) MAXX = DPCMR(I)                       PER03610
           IF(DPCMR(I) .LT. MINX) MINX = DPCMR(I)                       PER03620
120      DPTMR(I) = ((PTMR(I) - PTMR(163)) / PTMR(163)) * 100.0         PER03630
         DPITR(I) = ((PITR(I) - PITR(163)) / PITR(163)) * 100.0         PER03640
         DPOTR(I) = ((POTR(I) - POTR(163)) / POTR(163)) * 100.0         PER03650
         DPTTR(I) = ((PTTR(I) - PTTR(163)) / PTTR(163)) * 100.0         PER03660
         DPTAC(I) = ((PTAC(I) - PTAC(163)) / PTAC(163)) * 100.0         PER03670
          IF(DPTAC(I) .GT. MAXY) MAXY = DPTAC(I)                        PER03680
          IF(DPTMR(I) .GT. MAXY) MAXY = DPTMR(I)                        PER03690
          IF(DPTTR(I) .GT. MAXY) MAXY = DPTTR(I)                        PER03700
          IF(DPTAC(I) .LT. MINY) MINY = DPTAC(I)                        PER03710
          IF(DPTMR(I) .LT. MINY) MINY = DPTMR(I)                        PER03720
          IF(DPTTR(I) .LT. MINY) MINY = DPTTR(I)                        PER03730
140   CONTINUE                                                          PER03740
      CALL GRAF1C                                                       PER03750
      CALL GRAF1D                                                       PER03760
C-------------------------------------------------------------------    PER03770
      VF = 0.0                                                          PER03780
      MINB = 1.0                                                        PER03790
      MAXB = 0.0                                                        PER03800
      DO 150 I = 1,324                                                  PER03810
         CALL CONST                                                     PER03820
         AMR = RMR(I)**2.0*PIE                                          PER03830
         IF(K .NE.1) GO TO 142                                          PER03840
```

```
                VTMR = RVMR*RMR(I)                                      PER03850
                ARMR = VF / (RVMR*RMR(I))                               PER03860
                SDMR = IBMR*CMR / (PIE*RMR(I))                          PER03870
142         IF(K .NE. 2) GO TO 144                                      PER03880
                RVMR = VTMR2/RMR(I)                                     PER03890
                VTMR = RVMR*RMR(I)                                      PER03900
                ARMR = VF / (RVMR*RMR(I))                               PER03910
                SDMR = IBMR*CMR1 / (PIE*RMR(I))                         PER03920
144         IF(K .NE. 3) GO TO 146                                      PER03930
                CMR = SDMR3*PIE*RMR(I)/IBMR                             PER03940
                SDMR = IBMR*CMR / (PIE*RMR(I))                          PER03950
                RVMR = RVMR1                                            PER03960
                ARMR = VF / (RVMR*RMR(I))                               PER03970
                VTMR = RVMR*RMR(I)                                      PER03980
146         IF(K .NE. 4) GO TO 148                                      PER03990
                CMR = SDMR3*PIE*RMR(I)/IBMR                             PER04000
                SDMR = IBMR*CMR / (PIE*RMR(I))                          PER04010
                RVMR = VTMR2/RMR(I)                                     PER04020
                VTMR = RVMR*RMR(I)                                      PER04030
                ARMR = VF / (RVMR*RMR(I))                               PER04040
148         CALL VELMR                                                  PER04050
            CALL POWMR                                                  PER04060
            CALL VELTR                                                  PER04070
            CALL POWTR                                                  PER04080
            FMERT(I) = PTMR(I) / (PTMR(I) + POMR(I))                    PER04090
            IF(FMERT(I) .GT. MAXB) MAXB = FMERT(I)                      PER04100
            IF(FMERT(I) .LT. MINB) MINB = FMERT(I)                      PER04110
150     CONTINUE                                                        PER04120
C-------------------------------------------------------------------    PER04130
        MINC = 500.0                                                    PER04140
        MAXC = -500.0                                                   PER04150
        DO 155 I = 1,324                                                PER04160
           DFMERT(I) = ((FMERT(I) - FMERT(163)) / FMERT(163)) * 100.0   PER04170
             IF(DFMERT(I) .GT. MAXC) MAXC = DFMERT(I)                   PER04180
             IF(DFMERT(I) .LT. MINC) MINC = DFMERT(I)                   PER04190
155     CONTINUE                                                        PER04200
           CALL GRAFIE                                                  PER04210
        RETURN                                                          PER04220
        END                                                             PER04230
C*****************************************************************    PER04240
C                                                                       PER04250
C       SUBROUTINE TO CALCULATE THE ENDURANCE  VELOCITY                 PER04260
C                                                                       PER04270
C*****************************************************************    PER04280
C*****************************************************************    PER04290
        SUBROUTINE ENDUR                                                PER04300
        IMPLICIT REAL (A-H,L-Z)                                         PER04310
        COMMON /A/ AMR,ARMR,ARTR,ATR,CDCMR,CDOTR,CMR,CTMR,CTR,CTTR,     PER04320
```

```
     * DA,DEN,EFPAF,EFPAV,GE,HD,L,PA,RADILS,RTR,RTHT,RVMR,RVTR,SDMR,      PER04330
     * SDTR,SKDHT,TEMP,W,VF,VV,IBTR,IBMR,DENSSL,PIE,PTMIN(400),VIMR,      PER04340
     * VITR,VTTR,VTMR,RANMAX,THETA,DELTA,SHPRAN(400),VV1,VF1,IENG,SDMR3, PER04350
     * VTMR2,DIFF,SFCM,SFCN,SFCC,SHPM,SHPN,SHPC,CMR1,RVMR1,RRMR          PER04360
       COMMON /B/ PIMR(400),POMR(400),PPMR(400),PCMR(400),PITR(400),     PER04370
     * POTR(400),PTMR(400),PTTR(400),PTAC(400)                          PER04380
       COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,     PER04390
     * MAXZ,DMIN,DMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS,TEXT(200)    PER04400
       COMMON /W/ RCMAX(400),DRCMAX(400),VFRAN(400),DVFRAN(400),         PER04410
     * HCVALT(400),DHOVAL(400),SEVALT(400),DSEVAL(400),FMERT(400),       PER04420
     * DFMERT(400),VFEND(400),DVFEND(400)                               PER04430
       COMMON /Z/ VFEND1(400),VFEND2(400),VFEND3(400),VFEND4(400)        PER04440
C-----------------------------------------------------------------------PER04450
      MAX = 0.0                                                         PER04460
      MIN = 500.0                                                       PER04470
      CALL RHO                                                          PER04480
      DO 280 I = 1,324                                                  PER04490
         AMR = RMR(I)**2.0*PIE                                          PER04500
         IF(K .NE.1) GO TO 148                                          PER04510
            RVMR = RVMR1                                                PER04520
            VTMR = RVMR*RMR(I)                                          PER04530
            SDMR = IBMR*CMR / (PIE*RMR(I))                              PER04540
148      IF(K .NE. 2) GO TO 150                                         PER04550
            RVMR = VTMR2/RMR(I)                                         PER04560
            VTMR = RVMR*RMR(I)                                          PER04570
            SDMR = IBMR*CMR1 / (PIE*RMR(I))                             PER04580
150      IF(K .NE. 3) GO TO 152                                         PER04590
            CMR = SDMR3*PIE*RMR(I)/IBMR                                 PER04600
            SDMR = IBMR*CMR / (PIE*RMR(I))                              PER04610
            RVMR = RVMR1                                                PER04620
            VTMR = RVMR*RMR(I)                                          PER04630
152      IF(K .NE. 4) GO TO 154                                         PER04640
            CMR = SDMR3*PIE*RMR(I)/IBMR                                 PER04650
            SDMR = IBMR*CMR / (PIE*RMR(I))                              PER04660
            RVMR = VTMR2/RMR(I)                                         PER04670
            VTMR = RVMR*RMR(I)                                          PER04680
154      PTMIN(I) = 10000.0                                             PER04690
         VFEND(I) = 0.0                                                 PER04700
         DO 180 J = 1,20                                                PER04710
            VF = FLOAT(J) * 10.0                                        PER04720
            CALL CONST                                                  PER04730
            ARMR = VF / (RVMR*RMR(I))                                   PER04740
            CALL VELMR                                                  PER04750
            CALL POWMR                                                  PER04760
            CALL VELTR                                                  PER04770
            CALL POWTR                                                  PER04780
            IF (PTAC(I) .GT. PTMIN(I)) GO TO 160                        PER04790
               PTMIN(I) = PTAC(I)                                       PER04800
```

```
                VFEND(I) = VF/1.68885                                          PER04810
160           CONTINUE                                                         PER04820
180         CONTINUE                                                           PER04830
            VFEND(I) = VFEND(I) - 10.0                                         PER04840
            VFF = VFEND(I)                                                     PER04850
            DO 220 J = 1,20                                                    PER04860
               VF = (FLOAT(J)-1.0) + VFF                                       PER04870
               CALL CONST                                                      PER04880
               ARMR = VF / (RVMR*RMR(I))                                       PER04890
               CALL VELMR                                                      PER04900
               CALL POWMR                                                      PER04910
               CALL VELTR                                                      PER04920
               CALL POWTR                                                      PER04930
               IF (PTAC(I) .GT. PTMIN(I)) GO TO 200                            PER04940
                  PTMIN(I) = PTAC(I)                                           PER04950
                  VFEND(I) = VF/1.68889                                        PER04960
200           CONTINUE                                                         PER04970
220         CONTINUE                                                           PER04980
            VFEND(I) = VFEND(I) - 1.0                                          PER04990
            VFF = VFEND(I)                                                     PER05000
            DO 260 J = 1,200                                                   PER05010
               VF = ((FLOAT(J)/100)-0.01) + VFF                                PER05020
               CALL CONST                                                      PER05030
               ARMR = VF / (RVMR*RMR(I))                                       PER05040
               CALL VELMR                                                      PER05050
               CALL POWMR                                                      PER05060
               CALL VELTR                                                      PER05070
               CALL POWTR                                                      PER05080
               IF (PTAC(I) .GT. PTMIN(I)) GO TO 240                            PER05090
                  PTMIN(I) = PTAC(I)                                           PER05100
                  VFEND(I) = VF/1.68889                                        PER05110
240           CONTINUE                                                         PER05120
260         CONTINUE                                                           PER05130
            VFEND(I) = VFEND(I) - 0.01                                         PER05140
            IF(K .EQ. 1) VFEND1(I) = VFEND(I)                                  PER05150
            IF(K .EQ. 2) VFEND2(I) = VFEND(I)                                  PER05160
            IF(K .EQ. 3) VFEND3(I) = VFEND(I)                                  PER05170
            IF(K .EQ. 4) VFEND4(I) = VFEND(I)                                  PER05180
         IF(VFEND(I) .LT. MIN) MIN = VFEND(I)                                  PER05190
         IF(VFEND(I) .GT. MAX) MAX = VFEND(I)                                  PER05200
280      CONTINUE                                                              PER05210
C-------------------------------------------------------------------------     PER05220
         MAXY = -500.0                                                         PER05230
         MINY = 500.0                                                          PER05240
         DO 480 I = 1,324                                                      PER05250
            DVFEND(I) = ((VFEND(I) - VFEND(163)) / VFEND(163)) * 100.0         PER05260
            IF(DVFEND(I) .GT. MAXY) MAXY = DVFEND(I)                           PER05270
            IF(DVFEND(I) .LT. MINY) MINY = DVFEND(I)                           PER05280
```

```
480   CONTINUE                                                                  PER05290
      IF(IANS .EQ. 3 .OR. IANS .EQ. 6) GO TO 482                                PER05300
      CALL GRAF2                                                                PER05310
482   CONTINUE                                                                  PER05320
      RETURN                                                                    PER05330
      END                                                                       PER05340
C*************************************************************************     PER05350
C                                                                               PER05360
C       SUBROUTINE TO CALCULATE THE MAXIMUM RATE OF CLIMB                       PER05370
C                                                                               PER05380
C*************************************************************************     PER05390
C*************************************************************************     PER05400
      SUBROUTINE MAXRC                                                          PER05410
      IMPLICIT REAL (A-H,L-Z)                                                   PER05420
      COMMON /A/ AMR,ARMR,ARTR,ATR,CDCMR,CDOTR,CMR,CTMR,CTR,CTTR,               PER05430
     * DA,DEN,EFPAF,EFPAV,GE,HD,L,PA,RADIUS,RTR,RTHT,RVMR,RVTR,SDMR,            PER05440
     * SDTR,SKDHT,TEMP,W,VF,VV,IBTR,IBMR,CENSSL,PIE,PTMIN(400),VIMR,            PER05450
     * VITR,VTTR,VTMR,RANMAX,THETA,DELTA,SHPRAN(400),VV1,VF1,IENG,SDMR3,        PER05460
     * VTMR2,DIFF,SFCM,SFCN,SFCC,SHPM,SHPN,SHFC,CMR1,RVMR1,RRMR                 PER05470
      COMMON /B/ PIMR(400),POMR(400),PPMR(400),PCMR(400),PITR(400),             PER05480
     * PCTR(400),PTMR(400),PTTR(400),PTAC(400)                                  PER05490
      COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,             PER05500
     * MAXZ,DMIN,DMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS                    PER05510
      COMMON /D/ RCMAX(400),DRCMAX(400),VFRAN(400),DVFRAN(400),                 PER05520
     * HOVALT(400),DHOVAL(400),SEVALT(400),DSEVAL(400),FMERT(400),             PER05530
     * DFMERT(400),VFEND(400),DVFEND(400)                                       PER05540
      COMMON /Z/ VFEND1(400),VFEND2(400),VFEND3(400),VFEND4(400)                PER05550
C-------------------------------------------------------------------------      PER05560
      PA = 0.0                                                                  PER05570
      TEMP = 0.0                                                                PER05580
      DA = 0.0                                                                  PER05590
      IF(IENG .EQ. 1) PTAVAL = (FLOAT(IENG)*SHPM - 10.0) * 0.97                 PER05600
      IF(IENG .EQ. 2) PTAVAL = (FLOAT(IENG)*SHPM - 10.0)*0.9*0.97               PER05610
      IF(IENG .EQ. 3) PTAVAL = (FLOAT(IENG)*SHPM - 10.0)*0.9*0.94               PER05620
      CALL RHO                                                                  PER05630
      MAX = 0.0                                                                 PER05640
      MIN = 8000.0                                                              PER05650
      DO 580 I = 1,324                                                          PER05660
         AMR = RMR(I)**2.0*PIE                                                  PER05670
         IF(K .NE.1) GO TO 490                                                  PER05680
              VF = VFEND1(I)                                                    PER05690
              VTMR = RVMR1*RMR(I)                                               PER05700
              SDMR = IBMR*CMR1 / (PIE*RMR(I))                                   PER05710
490      IF(K .NE. 2) GO TO 492                                                 PER05720
              VF = VFEND2(I)                                                    PER05730
              RVMR = VTMR2/RMR(I)                                               PER05740
              VTMR = RVMR*RMR(I)                                                PER05750
              SDMR = IBMR*CMR1 / (PIE*RMR(I))                                   PER05760
```

```
492       IF(K .NE. 3) GO TO 494                                                PER05770
              VF = VFEND3(I)                                                    PER05780
              CMR = SDMR3*PIE*RMR(I)/IBMR                                       PER05790
              SDMR = IBMR*CMR / (PIE*RMR(I))                                    PER05800
              VTMR = RVMR1*RMR(I)                                               PER05810
494       IF(K .NE. 4) GO TO 496                                                PER05820
              VF = VFEND4(I)                                                    PER05830
              CMR = SDMR3*PIE*RMR(I)/IBMR                                       PER05840
              SDMR = IBMR*CMR / (PIE*RMR(I))                                    PER05850
              RVMR = VTMR2/RMR(I)                                               PER05860
              VTMR = RVMR*RMR(I)                                                PER05870
496           DO 500 J = 1,80                                                   PER05880
              VV = FLOAT(J)*100.0                                               PER05890
              CALL CONST                                                        PER05900
              ARMR = VF / (RVMR*RMR(I))                                         PER05910
              CALL VELMR                                                        PER05920
              CALL POWMR                                                        PER05930
              CALL VELTR                                                        PER05940
              CALL POWTR                                                        PER05950
              IF (PTAC(I) .GT. PTAVAL) GO TO 520                                PER05960
              VF = VF/1.68889                                                   PER05970
500           CONTINUE                                                          PER05980
520           RCMAXX = (VV*60.0) - 100.0                                        PER05990
              VF = VF/1.68889                                                   PER06000
              DO 540 J = 1,100                                                  PER06010
              VV = FLOAT(J)*1.0 + RCMAXX                                        PER06020
              CALL CONST                                                        PER06030
              ARMR = VF / (RVMR*RMR(I))                                         PER06040
              CALL VELMR                                                        PER06050
158           CALL POWMR                                                        PER06060
159           CALL VELTR                                                        PER06070
              CALL POWTR                                                        PER06080
              IF (PTAC(I) .GT. PTAVAL) GO TO 560                                PER06090
              VF = VF/1.68889                                                   PER06100
540           CONTINUE                                                          PER06110
560           RCMAX(I) = (VV*60.0)-1.0                                          PER06120
          IF(RCMAX(I) .LT. MIN) MIN = RCMAX(I)                                  PER06130
          IF(RCMAX(I) .GT. MAX) MAX = RCMAX(I)                                  PER06140
580       CONTINUE                                                              PER06150
C-------------------------------------------------------------------------      PER06160
          MAXY = -500.0                                                         PER06170
          MINY = 500.0                                                          PER06180
          DO 700 I = 1,324                                                      PER06190
              DRCMAX(I) = ((RCMAX(I) - RCMAX(163)) / RCMAX(163)) * 100.0        PER06200
              IF(DRCMAX(I) .GT. MAXY) MAXY = DRCMAX(I)                          PER06210
              IF(DRCMAX(I) .LT. MINY) MINY = DRCMAX(I)                          PER06220
700       CONTINUE                                                              PER06230
          CALL GRAF3                                                            PER06240
```

```
      RETURN                                                                    PER06250
      END                                                                       PER06260
C*****************************************************************           PER06270
C                                                                               PER06280
C     SUBROUTINE TO CALCULATE THE MAXIMUM RANGE VELOCITY                        PER06290
C                                                                               PER06300
C*****************************************************************           PER06310
C*****************************************************************           PER06320
      SUBROUTINE RANGE                                                          PER06330
      IMPLICIT REAL (A-H,L-Z)                                                   PER06340
      COMMON /A/ AMR,ARMR,ARTR,ATR,CDOMR,CDOTR,CMR,CTMR,CTR,CTTR,               PER06350
     * DA,DEN,EFPAF,EFPAV,GE,HD,L,PA,RADIUS,RTR,RTHT,RVMR,RVTR,SDMR,            PER06360
     * SDTR,SKDHT,TEMP,W,WF,VV,IBTR,IBMR,DENSSL,PIE,PTMIN(400),VIMR,            PER06370
     * VITR,VTTR,VTMR,RANMAX,THETA,DELTA,SHPRAN(400),VV1,VF1,IENG,SDMR3,PER06380
     * VTMR2,DIFF,SFCM,SFCN,SFCC,SHPM,SHPN,SHPC,CMR1,RVMR1,RRMR                 PER06390
      COMMON /B/ PIMR(400),POMR(400),PPMR(400),PCMR(400),PITR(400),             PER06400
     * PCTR(400),PTMR(400),PTTR(400),PTAC(400)                                  PER06410
      COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,            PER06420
     * MAXZ,CMIN,DMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS,TEXT(200)          PER06430
      COMMON /W/ RCMAX(400),DRCMAX(400),VFRAN(400),DVFRAN(400),                 PER06440
     * HOVALT(400),DHOVAL(400),SEVALT(400),DSEVAL(400),FMERT(400),             PER06450
     * DFMERT(400),VFEND(400),DVFEND(400)                                       PER06460
C-----------------------------------------------------------------              PER06470
      MIN = 500.0                                                               PER06480
      MAX = -500.0                                                              PER06490
      PA = 4000.0                                                               PER06500
      TEMP = 95.0                                                               PER06510
      CALL RHO                                                                  PER06520
      WFM = SFCM*SHPM                                                           PER06530
      WFN = SFCN*SHPN                                                           PER06540
      WFC = SFCC*SHPC                                                           PER06550
      BHAT = (WFM-WFC) / (SHPM-SHPC)                                            PER06560
      AHAT = WFM - (BHAT*SHPM)                                                  PER06570
      PSHP = FLOAT(IENG)*AHAT*DELTA*SQRT(THETA)/BHAT                            PER06580
      DO 900 I = 1,324                                                          PER06590
         AMR = RMR(I)**2.0*PIE                                                  PER06600
         RANMAX = 0.0                                                           PER06610
         VV = 0.0                                                               PER06620
         IF(K .NE.1) GO TO 730                                                  PER06630
            VTMR = RVMR1*RMR(I)                                                 PER06640
            SDMR = IBMR*CMR1 / (PIE*RMR(I))                                     PER06650
730      IF(K .NE. 2) GO TO 732                                                 PER06660
            RVMR = VTMR2/RMR(I)                                                 PER06670
            VTMR = RVMR*RMR(I)                                                  PER06680
            SDMR = IBMR*CMR1 / (PIE*RMR(I))                                     PER06690
732      IF(K .NE. 3) GO TO 734                                                 PER06700
            CMR = SDMR3*PIE*RMR(I)/IBMR                                         PER06710
            SDMR = IBMR*CMR / (PIE*RMR(I))                                      PER06720
```

```
      VTMR = RVMR1*RMR(I)                                              PER06730
734   IF(K .NE. 4) GO TO 736                                           PER06740
      CMR = SDMR3*PIE*RMR(I)/IBMR                                      PER06750
      SDMR = IBMR*CMR / (PIE*RMR(I))                                   PER06760
      RVMR = VTMR2/RMR(I)                                              PER06770
      VTMR = RVMR*RMR(I)                                               PER06780
736   DO 740 J = 1,20                                                  PER06790
      VF = FLOAT(J)*10.0                                               PER06800
      CALL CONST                                                       PER06810
      ARMR = VF / (RVMR*RMR(I))                                        PER06820
      CALL VELMR                                                       PER06830
      CALL POWMR                                                       PER06840
      CALL VELTR                                                       PER06850
      CALL POWTR                                                       PER06860
      DE = 550.0*(PTAC(I)+PSHP) / VF                                   PER06870
      WDE = W / DE                                                     PER06880
      IF (WDE .LE. RANMAX) GO TO 750                                   PER06890
         RANMAX = WDE                                                  PER06900
         VFRAN(I) = VF/1.68889                                         PER06910
740   CONTINUE                                                         PER06920
750   CONTINUE                                                         PER06930
      VFF = VFRAN(I)                                                   PER06940
      RANMAX = 0.0                                                     PER06950
      DO 820 J = 1,20                                                  PER06960
      VF = FLOAT(J)-1.0 + VFF                                          PER06970
      CALL CONST                                                       PER06980
      ARMR = VF / (RVMR*RMR(I))                                        PER06990
      CALL VELMR                                                       PER07000
      CALL POWMR                                                       PER07010
      CALL VELTR                                                       PER07020
      CALL POWTR                                                       PER07030
      DE = 550.0 * (PTAC(I)+PSHP) / VF                                 PER07040
      IF(DE .EQ. 0.0) GO TO 780                                        PER07050
      WDE = W / DE                                                     PER07060
      GO TO 800                                                        PER07070
780   WDE = 0.0                                                        PER07080
800   IF (WDE .LT. RANMAX) GO TO 850                                   PER07090
         RANMAX = WDE                                                  PER07100
         VFRAN(I) = VF/1.68889                                         PER07110
820   CONTINUE                                                         PER07120
850   CONTINUE                                                         PER07130
      VFF = VFRAN(I)                                                   PER07140
      RANMAX = 0.0                                                     PER07150
      DO 860 J = 1,201                                                 PER07160
      VF = (FLOAT(J-1)/100.0) + VFF                                    PER07170
      CALL CONST                                                       PER07180
      ARMR = VF / (RVMR*RMR(I))                                        PER07190
      CALL VELMR                                                       PER07200
```

```
                CALL POWMR                                                      PER07210
                CALL VELTR                                                      PER07220
                CALL POWTR                                                      PER07230
                DE = 550.0 * (PTAC(I)+PSHP) / VF                                PER07240
                WDE = W / DE                                                    PER07250
                IF (WDE .LT. RANMAX) GO TO 880                                  PER07260
                   RANMAX = WDE                                                 PER07270
                   VFRAN(I) = VF/1.68889                                        PER07280
                   SHPRAN(I) = PTAC(I)                                          PER07290
860             CONTINUE                                                        PER07300
880        CONTINUE                                                             PER07310
        IF(VFRAN(I) .LT. MIN) MIN = VFRAN(I)                                    PER07320
        IF(VFRAN(I) .GT. MAX) MAX = VFRAN(I)                                    PER07330
900     CONTINUE                                                                PER07340
C-------------------------------------------------------------------------      PER07350
        MAXY = -500.0                                                           PER07360
        MINY = 500.0                                                            PER07370
        DO 1100 I = 1,324                                                       PER07380
            DVFRAN(I) = ((VFRAN(I) - VFRAN(163)) / VFRAN(163)) * 100.0          PER07390
            IF(DVFRAN(I) .GT. MAXY) MAXY = DVFRAN(I)                            PER07400
            IF(DVFRAN(I) .LT. MINY) MINY = DVFRAN(I)                            PER07410
1100    CONTINUE                                                                PER07420
        IF ((MAXY - MINY) .GT. 0.5 ) GO TO 1102                                 PER07430
        MAXY = MAXY + 1.5                                                       PER07440
        MINY = MINY - 1.5                                                       PER07450
        MIN = MIN - 0.50                                                        PER07460
        MAX = MAX + 0.50                                                        PER07470
1102    CONTINUE                                                                PER07480
        CALL GRAF4                                                              PER07490
        RETURN                                                                  PER07500
        END                                                                     PER07510
C*********************************************************************        PER07520
C                                                                               PER07530
C       SUBROUTINE TO CALCULATE THE MAXIMUM HOVER CEILING (IGE)                 PER07540
C                                                                               PER07550
C*********************************************************************        PER07560
C*********************************************************************        PER07570
        SUBROUTINE HOVER                                                        PER07580
        IMPLICIT REAL (A-H,L-Z)                                                 PER07590
        COMMON /A/ AMR,ARMR,ARTR,ATR,CDOMR,CDOTR,CMR,CTMR,CTR,CTTR,             PER07600
       * DA,DEN,EFFAF,EFFAV,GE,HD,L,PA,RADIUS,RTR,RTHT,RVMR,RVTR,SDMR,          PER07610
       * SOTR,SKCHT,TEMP,W,VF,VV,IBTR,IBMR,DENSSL,PIE,PTMIN(400),VIMR,          PER07620
       * VITR,VTTR,VTMR,RANMAX,THETA,DELTA,SHPRAN(400),VV1,VF1,IENG,SDMR3,      PER07630
       * VTMR2,DIFF,SFCM,SFCN,SFCC,SHPM,SHPN,SHPC,CMR1,RVMR1,RRMR               PER07640
         COMMON /B/ PIMR(400),POMR(400),PPMR(400),PCMR(400),PITR(400),          PER07650
       * POTR(400),PTMR(400),PTTR(400),PTAC(400)                               PER07660
         COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,          PER07670
       * MAXZ,DMIN,DMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS,TEXT(200)        PER07680
```

```
      COMMON /W/ RCMAX(400),DRCMAX(400),VFRAN(400),DVFRAN(400),          PER07690
     * HCVALT(400),DHOVAL(400),SEVALT(400),DSEVAL(400),FMERT(400),       PER07700
     * DFMERT(400),VFEND(400),DVFEND(400)                                PER07710
C-----------------------------------------------------------------------PER07720
      VF = 0.0                                                           PER07730
      VV = 0.0                                                           PER07740
      SKCHT = 10.0                                                       PER07750
      MIN = 30000.0                                                      PER07760
      MAX = 0.0                                                          PER07770
      PA = 0.0                                                           PER07780
      TEMP = 0.0                                                         PER07790
      IF(IENG .EQ. 1) PTAVAL = (FLOAT(IENG)*SHPN - 10.0) * 0.97          PER07800
      IF(IENG .EQ. 2) PTAVAL = (FLOAT(IENG)*SHPN - 10.0)*0.9*0.97        PER07810
      IF(IENG .EQ. 3) PTAVAL = (FLOAT(IENG)*SHPN - 10.0)*0.9*0.94        PER07820
      DO 1240 I = 1,324                                                  PER07830
         AMR = RMR(I)**2.0*PIE                                           PER07840
         IF(K .NE.1) GO TO 1108                                          PER07850
            VTMR = RVMR1*RMR(I)                                          PER07860
            SDMR = IBMR*CMR1 / (PIE*RMR(I))                              PER07870
1108     IF(K .NE. 2) GO TO 1112                                         PER07880
            RVMR = VTMR2/RMR(I)                                          PER07890
            VTMR = RVMR*RMR(I)                                           PER07900
            SDMR = IBMR*CMR1 / (PIE*RMR(I))                              PER07910
1112     IF(K .NE. 3) GO TO 1114                                         PER07920
            CMR = SDMR3*PIE*RMR(I)/IBMR                                  PER07930
            SDMR = IBMR*CMR / (PIE*RMR(I))                               PER07940
            VTMR = RVMR1*RMR(I)                                          PER07950
1114     IF(K .NE. 4) GO TO 1116                                         PER07960
            CMR = SDMR3*PIE*RMR(I)/IBMR                                  PER07970
            SDMR = IBMR*CMR / (PIE*RMR(I))                               PER07980
            RVMR = VTMR2/RMR(I)                                          PER07990
            VTMR = RVMR*RMR(I)                                           PER08000
1116     ARMR = VF / (RVMR*RMR(I))                                       PER08010
         DO 1120 J = 1,30                                                PER08020
            CA = FLOAT(J)*1000.0                                         PER08030
            CALL RHO                                                     PER08040
            CALL CONST                                                   PER08050
            CALL VELMR                                                   PER08060
            CALL POWMR                                                   PER08070
            CALL VELTR                                                   PER08080
            CALL POWTR                                                   PER08090
            POWAA = PTAVAL*DELTA*SQRT(THETA)                             PER08100
            IF (PTAC(I) .LT. POWAA) GOTO 1120                            PER08110
               HCVALT(I) = CA                                            PER08120
               GO TO 1140                                                PER08130
1120        CONTINUE                                                     PER08140
1140     CONTINUE                                                        PER08150
         HOV = HOVALT(I) - 1000.0                                        PER08160
```

```
      DO 1160 J = 1,20                                                  PER08170
          DA = FLOAT(J)*50.0 + HOV                                      PER08180
          CALL RHO                                                      PER08190
          CALL CONST                                                    PER08200
          CALL VELMR                                                    PER08210
          CALL POWMR                                                    PER08220
          CALL VELTR                                                    PER08230
          CALL POWTR                                                    PER08240
          POWAA = PTAVAL*DELTA*SQRT(THETA)                              PER08250
          IF (PTAC(I) .LT. POWAA) GOTO 1160                             PER08260
             HOVALT(I) = DA                                             PER08270
             GO TO 1180                                                 PER08280
1160      CONTINUE                                                      PER08290
1180      CONTINUE                                                      PER08300
          HOV = HOVALT(I) - 50.0                                        PER08310
          DO 1200 J = 1,100                                             PER08320
          DA = FLOAT(J)*0.5 + HOV                                       PER08330
          CALL RHO                                                      PER08340
          CALL CONST                                                    PER08350
          CALL VELMR                                                    PER08360
          CALL POWMR                                                    PER08370
          CALL VELTR                                                    PER08380
          CALL POWTR                                                    PER08390
          POWAA = PTAVAL*DELTA*SQRT(THETA)                              PER08400
          IF (PTAC(I) .LT. POWAA) GOTO 1200                             PER08410
             HOVALT(I) = DA-0.5                                         PER08420
             GO TO 1220                                                 PER08430
1200      CONTINUE                                                      PER08440
1220      CONTINUE                                                      PER08450
      IF(HOVALT(I) .LT. MIN) MIN = HOVALT(I)                            PER08460
      IF(HOVALT(I) .GT. MAX) MAX = HOVALT(I)                            PER08470
1240  CONTINUE                                                          PER08480
C-----------------------------------------------------------------------PER08490
      MAXY = -500.0                                                     PER08500
      MINY = 500.0                                                      PER08510
      DO 1400 I = 1,324                                                 PER08520
          DHOVAL(I) = ((HOVALT(I) - HOVALT(163)) / HOVALT(163)) * 100.0 PER08530
          IF(DHOVAL(I) .GT. MAXY) MAXY = DHOVAL(I)                      PER08540
          IF(DHOVAL(I) .LT. MINY) MINY = DHOVAL(I)                      PER08550
1400  CONTINUE                                                          PER08560
      CALL GRAF5                                                        PER08570
      RETURN                                                            PER08580
      END                                                               PER08590
C*********************************************************************** PER08600
C                                                                       PER08610
C     SUBROUTINE TO CALCULATE THE MAXIMUM SERVICE CEILING               PER08620
C                                                                       PER08630
C*********************************************************************** PER08640
```

```
C*************************************************************************  PER08650
      SUBROUTINE CEIL                                                       PER08660
      IMPLICIT REAL (A-H,L-Z)                                               PER08670
      COMMON /A/ AMR,ARMR,ARTR,ATR,CDCMR,CDOTR,CMR,CTMR,CTR,CTTR,           PER08680
     * DA,DEN,EFPAF,EFPAV,GE,HD,L,PA,RADIUS,RTR,RTHT,RVMR,RVTR,SDMR,        PER08690
     * SDTR,SKCHT,TEMP,W,VF,VV,IBTR,IBMR,DENSSL,PIE,PTMIN(400),VIMR,        PER08700
     * VITR,VTTR,VTMR,RANMAX,THETA,DELTA,SHPRAN(400),VV1,VF1,IENG,SDMR3,    PER08710
     * VTMR2,DIFF,SFCM,SFCN,SFCC,SHPM,SHPN,SHFC,CMR1,RVMR1,RRMR             PER08720
      COMMON /B/ PIMR(400),POMR(400),PPMR(400),PCMR(400),PITR(400),         PER08730
     * POTR(400),PTMR(400),PTTR(400),PTAC(400)                             PER08740
      COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,         PER08750
     * MAXZ,DMIN,DMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS,TEXT(200)      PER08760
      COMMON /D/ RCMAX(400),DRCMAX(400),VFRAN(400),DVFRAN(400),             PER08770
     * HCVALT(400),DHCVAL(400),SEVALT(400),DSEVAL(400),FMERT(400),          PER08780
     * DFMERT(400),VFEND(400),DVFEND(400)                                   PER08790
      COMMON /Z/ VFEND1(400),VFEND2(400),VFEND3(400),VFEND4(400)            PER08800
C-------------------------------------------------------------------------  PER08810
      SKCHT = 2500.0                                                        PER08820
      MIN = 30000.0                                                         PER08830
      MAX = 0.0                                                             PER08840
      PA = 0.0                                                              PER08850
      TEMP = 0.0                                                            PER08860
      IF(IENG .EQ. 1) PTAVAL = (FLOAT(IENG)*SHPN - 10.0) * 0.97             PER08870
      IF(IENG .EQ. 2) PTAVAL = (FLOAT(IENG)*SHPN - 10.0)*0.9*0.97           PER08880
      IF(IENG .EQ. 3) PTAVAL = (FLOAT(IENG)*SHPN - 10.0)*0.9*0.94           PER08890
      DO 154C I = 1,324                                                     PER08900
         AMR = RMR(I)**2.0*PIE                                              PER08910
         IF(K .NE.1) GO TO 1408                                             PER08920
              VFF = VFEND1(I)                                               PER08930
              VTMR = RVMR1*RMR(I)                                           PER08940
              SDMR = IBMR*CMR1 / (PIE*RMR(I))                               PER08950
1408     IF(K .NE. 2) GO TO 1412                                            PER08960
              VFF = VFEND2(I)                                               PER08970
              RVMR = VTMR2/RMR(I)                                           PER08980
              VTMR = RVMR*RMR(I)                                            PER08990
              SDMR = IBMR*CMR1 / (PIE*RMR(I))                               PER09000
1412     IF(K .NE. 3) GO TO 1414                                            PER09010
              VFF = VFEND3(I)                                               PER09020
              CMR = SDMR3*PIE*RMR(I)/IBMR                                   PER09030
              SDMR = IBMR*CMR / (PIE*RMR(I))                                PER09040
              VTMR = RVMR1*RMR(I)                                           PER09050
1414     IF(K .NE. 4) GO TO 1416                                            PER09060
              CMR = SDMR3*PIE*RMR(I)/IBMR                                   PER09070
              SDMR = IBMR*CMR / (PIE*RMR(I))                                PER09080
              RVMR = VTMR2/RMR(I)                                           PER09090
              VTMR = RVMR*RMR(I)                                            PER09100
              VFF = VFEND4(I)                                               PER09110
1416     DO 1420 J = 1,30                                                   PER09120
```

```
                VF = VFF                                                        PERO9130
                DA = FLOAT(J)*1000.0                                            PERO9140
                CALL RHO                                                        PERO9150
                VV = 100.0                                                      PERO9160
                CALL CONST                                                      PERO9170
                ARMR = VF / (RVMR*RMR(I))                                       PERO9180
                CALL VELMR                                                      PERO9190
                CALL POWMR                                                      PERO9200
                CALL VELTR                                                      PERO9210
                CALL POWTR                                                      PERO9220
                POWAA = PTAVAL*DELTA*SQRT(THETA)                                PERO9230
                IF (PTAC(I) .LT. POWAA) GO TO 1420                              PERO9240
                   SEVALT(I) = DA                                               PERO9250
                   GO TO 1440                                                   PERO9260
1420          CONTINUE                                                          PERO9270
1440       CONTINUE                                                             PERO9280
           SEV = SEVALT(I) - 1000.0                                             PERO9290
           DO 1460 J = 1,20                                                     PERO9300
                VF = VFF                                                        PERO9310
                DA = FLOAT(J)*50.0 + SEV                                        PERO9320
                CALL RHO                                                        PERO9330
                VV = 100.0                                                      PERO9340
                CALL CONST                                                      PERO9350
                ARMR = VF / (RVMR*RMR(I))                                       PERO9360
                CALL VELMR                                                      PERO9370
                CALL POWMR                                                      PERO9380
                CALL VELTR                                                      PERO9390
                CALL POWTR                                                      PERO9400
                POWAA = PTAVAL*DELTA*SQRT(THETA)                                PERO9410
                IF (PTAC(I) .LT. POWAA) GO TO 1460                              PERO9420
                   SEVALT(I) = DA                                               PERO9430
                   GO TO 1480                                                   PERO9440
1460          CONTINUE                                                          PERO9450
1480       CONTINUE                                                             PERO9460
           SEV = SEVALT(I) - 50.0                                               PERO9470
           DO 1500 J = 1,100                                                    PERO9480
                VF = VFF                                                        PERO9490
                DA = FLOAT(J)*0.5 + SEV                                         PERO9500
                CALL RHO                                                        PERO9510
                VV = 100.0                                                      PERO9520
                CALL CONST                                                      PERO9530
                ARMR = VF / (RVMR*RMR(I))                                       PERO9540
                CALL VELMR                                                      PERO9550
                CALL POWMR                                                      PERO9560
                CALL VELTR                                                      PERO9570
                CALL POWTR                                                      PERO9580
                POWAA = PTAVAL*DELTA*SQRT(THETA)                                PERO9590
                IF (PTAC(I) .LT. POWAA) GO TO 1500                              PERO9600
```

```
                  SEVALT(I) = DA                                                PERO9610
                  GO TO 1520                                                    PERO9620
1500            CONTINUE                                                        PERO9630
1520        CONTINUE                                                            PERO9640
            SEVALT(I) = SEVALT(I) - 0.5                                         PERO9650
          IF(SEVALT(I) .LT. MIN) MIN = SEVALT(I)                                PERO9660
          IF(SEVALT(I) .GT. MAX) MAX = SEVALT(I)                                PERO9670
1540    CONTINUE                                                                PERO9680
C-------------------------------------------------------------------------      PERO9690
          MAXY = -500.0                                                         PERO9700
          MINY =  500.0                                                         PERO9710
          DO 1700 I = 1,324                                                     PERO9720
              DSEVAL(I) = ((SEVALT(I) - SEVALT(163)) / SEVALT(163)) * 100.0     PERO9730
              DRMR(I) = ((RMR(I) - RMR(163)) / RMR(163)) * 100.0                PERO9740
              IF(DSEVAL(I) .GT. MAXY) MAXY = DSEVAL(I)                          PERO9750
              IF(DSEVAL(I) .LT. MINY) MINY = DSEVAL(I)                          PERO9760
1700    CONTINUE                                                                PERO9770
          CALL GRAF6                                                            PERO9780
          RETURN                                                                PERO9790
          END                                                                   PERO9800
C=============================================================================  PERO9810
C=============                                    ==========================    PERO9820
C=================      SUB-GROUP A     ============================          PERO9830
C===========      GENERAL USE SUBROUTINES       ============================  PERO9840
C=============                                  ============================    PERO9850
C=============================================================================  PERO9860
C*****************************************************************************  PERO9870
C                                                                               PERO9880
C     SUBROUTINE TO CALCULATE DENSITY ALTITUDE                                  PERO9890
C                                                                               PERO9900
C*****************************************************************************  PERO9910
C*****************************************************************************  PERO9920
          SUBROUTINE RHO                                                        PERO9930
          IMPLICIT REAL (A-H,L-Z)                                               PERO9940
          COMMON /A/ AMR,ARMR,ARTR,ATR,CDCMR,CDOTR,CMR,CTMR,CTR,CTTR,           PERO9950
         * DA,DEN,EFPAF,EFPAV,GE,HD,L,PA,RADILS,RTR,RTHT,RVMR,RVTR,SDMR,        PERO9960
         * SDTR,SKOHT,TEMP,W,VF,VV,IBTR,IBMR,DENSSL,PIE,PTMIN(400),VIMR,        PERO9970
         * VITR,VTTR,VTMR,RANMAX,THETA,DELTA,SHPRAN(400),VV1,VF1,IENG,SDMR3,    PERO9980
         * VTMR2,DIFF,SFCM,SFCN,SFCC,SHPM,SHPN,SHPC,CMR1,RVMR1                  PERO9990
C-------------------------------------------------------------------------      PER10000
          IF (TEMP .EQ. 0.0 .OR. PA .EQ. 0.0 ) GO TO 10                         PER10010
          H = (1.0-(PA*6.875E-06))**5.2561 / ((TEMP-32.0)*0.5555+273.16)        PER10020
          DA = (1.0-(H*288.16)**0.23496) / 6.875E-06                            PER10030
10        DEN = 0.0023769*(1.0-6.875E-06*DA)**4.2561                            PER10040
          TEMP1 = 518.688*(1.0-6.875E-06*DA)                                    PER10050
          PRESS1 = 2116.22*(1.0-6.875E-06*DA)**5.2561                           PER10060
          DEN1 = DENSSL*(1.0-6.875E-06*DA)**4.2561                              PER10070
          THETA = TEMP1/518.688                                                 PER10080
```

```
      DELTA = PRESS1/2116.22                                                    PER1C090
      RETURN                                                                    PER1C100
      END                                                                       PER1C110
C*************************************************************************    PER1C120
C                                                                               PER1C130
C   SUBROUTINE TO CALCULATE INDUCED VELOCITY FOR MAIN ROTOR                     PER1C140
C                                                                               PER1C150
C*************************************************************************    PER1C160
C*************************************************************************    PER1C170
      SUBROUTINE VELMR                                                          PER1C180
      IMPLICIT REAL (A-H,L-Z)                                                   PER1C190
      COMMON /A/ AMR,ARMR,ARTR,ATR,CDCMR,CDOTR,CMR,CTMR,CTR,CTTR,               PER1C200
     * DA,DEN,EFPAF,EFPAV,GE,HD,L,PA,RADIUS,RTR,RTHT,RVMR,RVTR,SDMR,           PER1C210
     * SDTR,SKDHT,TEMP,W,VF,VV,IBTR,IBMR,DENSSL,PIE,PTMIN(400),VIMR,           PER1C220
     * VITR,VTTR,VTMR,RANMAX,THETA,DELTA,SHPRAN(400),VV1,VF1,IENG,SDMR3,       PER1C230
     * VTMR2,DIFF,SFCM,SFCN,SFCC,SHPM,SHPN,SHPC,CMR1,RVMR1                     PER1C240
C-------------------------------------------------------------------------    PER1C250
      VIHMR = SQRT(W/(2.0*DEN*AMR))                                             PER1C260
      VITMR = SQRT(-(VF**2./2.0) + SQRT((VF**2./2.0)**2.0 + VIHMR**4))          PER1C270
      VIMR = VITMR                                                              PER1C280
      IF (VF .NE. 0.0 .OR. VV .EQ. 0.0) GO TO 10                                PER1C290
      VIVMR = 0.5*(-VV + SQRT(VV + 4*VIHMR))                                    PER1C300
      VIMR = VIVMR                                                              PER1C310
10    CONTINUE                                                                  PER1C320
      RETURN                                                                    PER1C330
      END                                                                       PER1C340
C*************************************************************************    PER1C350
C                                                                               PER1C360
C     SUBROUTINE TO CALCULATE INDUCED VELOCITY FOR TAIL ROTOR                   PER1C370
C                                                                               PER1C380
C*************************************************************************    PER1C390
C*************************************************************************    PER1C400
      SUBROUTINE VELTR                                                          PER1C410
      IMPLICIT REAL (A-H,L-Z)                                                   PER1C420
      COMMON /A/ AMR,ARMR,ARTR,ATR,CDCMR,CDOTR,CMR,CTMR,CTR,CTTR,               PER1C430
     * DA,DEN,EFPAF,EFPAV,GE,HD,L,PA,RADIUS,RTR,RTHT,RVMR,RVTR,SDMR,           PER1C440
     * SDTR,SKDHT,TEMP,W,VF,VV,IBTR,IBMR,DENSSL,PIE,PTMIN(400),VIMR,           PER1C450
     * VITR,VTTR,VTMR,RANMAX,THETA,DELTA,SHPRAN(400),VV1,VF1,IENG,SDMR3,       PER1C460
     * VTMR2,DIFF,SFCM,SFCN,SFCC,SHPM,SHPN,SHPC,CMR1,RVMR1                     PER1C470
      COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,            PER1C480
     * MAXZ,CMIN,CMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS                    PER1C490
      COMMON /B/ PIMR(400),POMR(400),PPMR(400),PCMR(400),PITR(400),            PER1C500
     * POTR(400),PTMR(400),PTTR(400),PTAC(400)                                 PER1C510
C-------------------------------------------------------------------------    PER1C520
      VIHTR = SQRT(PTMR(I)*550.0/(2.0*DEN*ATR*RVMR*L))                          PER1C530
      VITTR = SQRT(-(VF**2./2.)+SQRT((VF**2./2.)**2.+VIHTR**4.))                PER1C540
      VITR = VITTR                                                              PER1C550
      RETURN                                                                    PER1C560
```

```
      END                                                                PER10570
C*****************************************************************      PER10580
C                                                                        PER10590
C     SUBROUTINE TO CALCULATE POWER REQUIREMENTS FOR MAIN ROTOR          PER10600
C                                                                        PER10610
C*****************************************************************      PER10620
C*****************************************************************      PER10630
      SUBROUTINE POWMR                                                   PER10640
      IMPLICIT REAL (A-H,L-Z)                                            PER10650
      COMMON /A/ AMR,ARMR,ARTR,ATR,CDCMR,CDOTR,CMR,CTMR,CTR,CTTR,        PER10660
     * DA,DEN,EFPAF,EFPAV,GE,HD,L,PA,RADIUS,RTR,RTHT,RVMR,RVTR,SDMR,      PER10670
     * SOTR,SKCHT,TEMP,W,VF,VV,IBTR,IBMR,DENSSL,PIE,PTMIN(400),VIMR,      PER10680
     * VITR,VTTR,VTMR,RANMAX,THETA,DELTA,SHPRAN(400),VV1,VF1,IENG,SDMR3,  PER10690
     * VTMR2,DIFF,SFCM,SFCN,SFCC,SHPM,SHPN,SHPC,CMR1,RVMR1                PER10700
      COMMON /B/ PIMR(400),POMR(400),PPMR(400),PCMR(400),PITR(400),      PER10710
     * POTR(400),PTMR(400),PTTR(400),PTAC(400)                           PER10720
      COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,      PER10730
     * MAXZ,CMIN,DMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS              PER10740
C-----------------------------------------------------------------       PER10750
      CTMR = W/(DEN*AMR*VTMR**2.0)                                       PER10760
      TLMR = 1.0 - (SQRT(2.0*CTMR) / FLOAT(IBMR))                        PER10770
      PIMR(I) = W*VIMR*GE / (TLMR*550.0)                                 PER10780
      POMR(I) = (SDMR*CDOMR*DEN*AMR*VTMR**3.0) * (1.0 + 4.3*ARMR**2.0)/  PER10790
     * (550.0 * 8.0)                                                     PER10800
      PPMR(I) = 0.5*DEN * (VF**3.0*EFPAF + VV**3.0*EFPAV) / 550.0        PER10810
      PCMR(I) = W*VV / 550.0                                             PER10820
      PTMR(I) = PIMR(I) + POMR(I) + PPMR(I) + PCMR(I)                    PER10830
      RETURN                                                             PER10840
      END                                                                PER10850
C*****************************************************************      PER10860
C                                                                        PER10870
C     SUBROUTINE TO CALCULATE POWER REQUIREMENTS FOR TAIL ROTOR          PER10880
C         AND POWER FOR TOTAL AIRCRAFT.                                  PER10890
C                                                                        PER10900
C*****************************************************************      PER10910
C*****************************************************************      PER10920
      SUBROUTINE POWTR                                                   PER10930
      IMPLICIT REAL (A-H,L-Z)                                            PER10940
      COMMON /A/ AMR,ARMR,ARTR,ATR,CDCMR,CDOTR,CMR,CTMR,CTR,CTTR,        PER10950
     * DA,DEN,EFPAF,EFPAV,GE,HD,L,PA,RADIUS,RTR,RTHT,RVMR,RVTR,SDMR,      PER10960
     * SOTR,SKCHT,TEMP,W,VF,VV,IBTR,IBMR,DENSSL,PIE,PTMIN(400),VIMR,      PER10970
     * VITR,VTTR,VTMR,RANMAX,THETA,DELTA,SHPRAN(400),VV1,VF1,IENG,SDMR3,  PER10980
     * VTMR2,DIFF,SFCM,SFCN,SFCC,SHPM,SHPN,SHPC,CMR1,RVMR1                PER10990
      COMMON /B/ PIMR(400),POMR(400),PPMR(400),PCMR(400),PITR(400),      PER11000
     * POTR(400),PTMR(400),PTTR(400),PTAC(400)                           PER11010
      COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,      PER11020
     * MAXZ,CMIN,DMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS              PER11030
C-----------------------------------------------------------------       PER11040
```

```
      CTTR = PTMR(I)*550.0 / (DEN*ATR*RVMR*L*VTTR**2.0)                    PER11050
      TLTR = 1.0 - SQRT(2.0*CTTR) / IBTR                                   PER11060
      PITR(I) = PTMR(I)*VITR / (L*RVMR*TLTR)                               PER11070
      POTR(I) = (SDTR*CDOTR*ATR*DEN*VTTR**3.0)* (1.0 + 4.3*ARTR**2.0)/     PER11080
     * (550.0 * 8.0)                                                       PER11090
      PTTR(I) = PITR(I) + POTR(I)                                          PER11100
      PTAC(I) = PTMR(I) + PTTR(I)                                          PER11110
      RETURN                                                               PER11120
      END                                                                  PER11130
C*********************************************************************   PER11140
C                                                                          PER11150
C     SUBROUTINE TO CALCULATE CONSTANTS                                    PER11160
C                                                                          PER11170
C*********************************************************************   PER11180
C*********************************************************************   PER11190
      SUBROUTINE CONST                                                     PER11200
      IMPLICIT REAL (A-H,L-Z)                                              PER11210
      COMMON /A/ AMR,ARMR,ARTR,ATR,CDOMR,CDOTR,CMR,CTMR,CTR,CTTR,          PER11220
     * DA,DEN,EFPAF,EFPAV,GE,HD,L,PA,RADIUS,RTR,RTHT,RVMR,RVTR,SDMR,       PER11230
     * SDTR,SKDHT,TEMP,W,VF,VV,IBTR,IBMR,DENSSL,PIE,PTMIN(400),VIMR,       PER11240
     * VITR,VTTR,VTMR,RANMAX,THETA,DELTA,SHPRAN(400),VV1,VF1,IENG,SDMR3,   PER11250
     * VTMR2,DIFF,SFCM,SFCN,SFCC,SHPM,SHPN,SHPC,CMR1,RVMR1                 PER11260
      COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,        PER11270
     * MAXZ,CMIN,CMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS                PER11280
C---------------------------------------------------------------------   PER11290
      PIE = 3.141593                                                       PER11300
      VF = VF * 1.68889                                                    PER11310
      VV = VV / 60.0                                                       PER11320
      ATR = PIE * RTR**2.0                                                 PER11330
      VTTR = RVTR * RTR                                                    PER11340
      ARTR = VF / (RVTR*RTR)                                               PER11350
      SDTR = IETR*CTR / (PIE*RTR)                                          PER11360
      HD = (SKDHT+RTHT) / (RMR(I)*2.0)                                     PER11370
      IF(HD .GT. 1.6) GO TO 10                                             PER11380
      GE = -0.1276*HD**4 + 0.708*HD**3 - 1.4569*HD**2 + 1.3432*HD +        PER11390
     *  0.5147                                                             PER11400
      GO TO 11                                                             PER11410
10    GE = 1.0                                                             PER11420
11    CONTINUE                                                             PER11430
      RETURN                                                               PER11440
      END                                                                  PER11450
C=====================================================================   PER11460
C============                                                              PER11470
C==================        SUB-GROUP C        ========================   PER11480
C============          GRAPHS SUBROUTINES                                 PER11490
C================                                                        PER11500
C=====================================================================   PER11510
C*********************************************************************   PER11520
```

```
C                                                                       PER11530
C      SUBROUTINE TO CREATE GRAPHS FOR POWER AND FIGURE OF MERIT        PER11540
C          VS RADIUS                                                    PER11550
C                                                                       PER11560
C***********************************************************************PER11570
C***********************************************************************PER11580
       SUBROUTINE GRAFIC                                                PER11590
       IMPLICIT REAL (A-H,L-Z)                                          PER11600
        COMMON /B/ PIMR(400),POMR(400),PPMR(400),PCMR(400),PITR(400),   PER11610
      * POTR(400),PTMR(400),PTTR(400),PTAC(400)                         PER11620
        COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,   PER11630
      * MAXZ,CMIN,CMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS,TEXT(200)  PER11640
        COMMON /Y/DPIMR(400),DPOMR(400),DPPMR(400),DPCMR(400),DPTMR(400),PER11650
      * DPITR(400),DPOTR(400),DPTAC(400),DPTTR(400)                     PER11660
        CALL CCMPRS                                                     PER11670
        CALL PAGE (11.0,8.5)                                            PER11680
        CALL PHYSOR(1.5,1.5)                                            PER11690
        CALL AREA2D (2.50,4.50)                                         PER11700
        CALL XNAME ('RADIUS OF MAIN ROTOR (FT)$',100)                   PER11710
        CALL YNAME ('POWER REQUIRED (SHP)$',100)                        PER11720
        CALL GRAF (MINZ,'SCALE',MAXZ,0.0,'SCALE',MAX)                   PER11730
        CALL LEGLIN                                                     PER11740
        CALL DASH                                                       PER11750
        CALL CURVE (RMR,PTTR,322,0)                                     PER11760
        CALL CHNCOT                                                     PER11770
        CALL CURVE (RMR,PTMR,322,0)                                     PER11780
        CALL CHNDSH                                                     PER11790
        CALL CURVE (RMR,PTAC,322,0)                                     PER11800
        MAXLIN=LINEST(TEXT,100,30)                                      PER11810
        CALL HEIGHT(0.1)                                                PER11820
        CALL LINES('TAIL ROTOR POWER$',TEXT,1)                          PER11830
        CALL LINES('MAIN ROTOR POWER$',TEXT,2)                          PER11840
        CALL LINES('TOTAL POWER$',TEXT,3)                               PER11850
        CALL LEGEND(TEXT,3,0.4,1.5)                                     PER11860
        CALL BLREC(0.3,1.42,1.95,0.75,1.2)                              PER11870
        CALL RESET('HEIGHT')                                            PER11880
        CALL DOT                                                        PER11890
        CALL GRID (1,2)                                                 PER11900
        CALL ENDGR(0)                                                   PER11910
C-----------------------------------------------------------------------PER11920
        CALL PHYSOR(5.5,1.5)                                            PER11930
        CALL AREA2D (2.50,4.50)                                         PER11940
        CALL XNAME ('RADIUS OF MAIN ROTOR (% CHANGE)$',100)             PER11950
        CALL YNAME ('POWER REQUIRED (% CHANGE)$',100)                   PER11960
        CALL GRAF (CMIN,'SCALE',CMAX,MINY,'SCALE',MAXY)                 PER11970
        CALL LEGLIN                                                     PER11980
        CALL DASH                                                       PER11990
        CALL CURVE (DRMR,DPTTR,324,0)                                   PER12000
```

```
      CALL CHNCCT                                                       PER12010
      CALL CURVE (DRMR,DPTMR,322,0)                                     PER12020
      CALL CHNCSH                                                       PER12030
      CALL CURVE (DRMR,DPTAC,322,0)                                     PER12040
      MAXLIN=LINEST(TEXT,100,30)                                        PER12050
      CALL HEIGHT(0.1)                                                  PER12060
      CALL LINES('TAIL ROTOR POWER$',TEXT,1)                            PER12070
      CALL LINES('MAIN ROTOR POWER$',TEXT,2)                            PER12080
      CALL LINES('TOTAL POWER$',TEXT,3)                                 PER12090
      CALL LEGEND(TEXT,3,0.4,3.8)                                       PER12100
      CALL BLREC(0.3,3.7,1.95,0.75,1.2)                                 PER12110
      CALL RESET('HEIGHT')                                              PER12120
      CALL DOT                                                          PER12130
      CALL GRID (1,2)                                                   PER12140
      CALL ENDGR(0)                                                     PER12150
C-----------------------------------------------------------------------PER12160
      CALL PHYSOR(1.5,1.5)                                              PER12170
      CALL AREA2D (6.50,4.70)                                           PER12180
      CALL HEADIN ('POWER VERSUS RADIUS$',19,1.4,3)                     PER12190
      IF(K .NE. 1 ) GO TO 8                                             PER12200
      CALL HEADIN ('CHORD & ROTATIONAL VELOCITY HELD CONSTANT$',41,      PER12210
     *             0.8,3)                                               PER12220
      CALL HEADIN ('SOLIDITY, TIP VELOCITY & ADVANCE RATIO$',38,0.8,4)  PER12230
      CALL HEADIN('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)              PER12240
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                           PER12250
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                            PER12260
      CALL MESSAG('CASE 1$',100,8.7,6.0)                                PER12270
8     IF(K .NE. 2) GO TO 10                                             PER12280
      CALL HEADIN ('CHORD,TIP VELOCITY & ADVANCE RATIO HELD CONSTANT$', PER12290
     *     48,0.8,4)                                                    PER12300
      CALL HEADIN ('SOLIDITY, ROTATIONAL VELOCITY$',29,0.8,4)           PER12310
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)             PER12320
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                           PER12330
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                            PER12340
      CALL MESSAG('CASE 2$',100,8.7,6.0)                                PER12350
10    IF( K .NE. 3) GO TO 12                                            PER12360
      CALL HEADIN ('SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT$',     PER12370
     *     44,0.8,4)                                                    PER12380
      CALL HEADIN ('CHORD,ADVANCE RATIO & TIP VELOCITY$',34,0.8,4)      PER12390
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)             PER12400
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                           PER12410
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                            PER12420
      CALL MESSAG('CASE 3$',100,8.7,6.0)                                PER12430
12    IF( K .NE. 4) GO TO 14                                            PER12440
      CALL HEADIN('SOLIDITY,ADVANCE RATIO & TIP VELOCITY HELD CONSTANT$'PER12450
     *,51,0.8,4)                                                        PER12460
      CALL HEADIN ('CHORD & ROTATIONAL VELOCITY$',27,0.8,4)             PER12470
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)             PER12480
```

```
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                          PER12490
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                           PER12500
      CALL MESSAG('CASE 4$',100,8.7,6.0)                               PER12510
14    CALL ENDPL(0)                                                    PER12520
      RETURN                                                           PER12530
      END                                                              PER12540
C*****************************************************************    PER12550
C                                                                      PER12560
C     SUBROUTINE  TO CREATE GRAPH OF POWER (INDUCED,PROFILE, ETC.)     PER12570
C          VS RADIUS.                                                  PER12580
C                                                                      PER12590
C*****************************************************************    PER12600
C*****************************************************************    PER12610
      SUBROUTINE GRAF1D                                                PER12620
      IMPLICIT REAL (A-H,L-Z)                                          PER12630
       COMMON /B/ PIMR(400),POMR(400),PPMR(400),PCMR(400),PITR(400),   PER12640
     * POTR(400),PTMR(400),PTTR(400),PTAC(400)                        PER12650
       COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,   PER12660
     * MAXZ,DMIN,DMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS,TEXT(200)  PER12670
       COMMON /Y/DPIMR(400),DPOMR(400),DPPMR(400),DPCMR(400),DPTMR(400),PER12680
     * DPITR(400),DPOTR(400),DPTAC(400)                               PER12690
      CALL COMPRS                                                      PER12700
      CALL PAGE (11.0,8.5)                                             PER12710
      CALL PHYSOR(1.5,1.5)                                             PER12720
      CALL AREA2D (2.50,4.50)                                          PER12730
      CALL XNAME ('RADIUS OF MAIN ROTOR (FT)$',100)                    PER12740
      CALL YNAME ('POWER REQUIRED (SHP)$',100)                         PER12750
      CALL GRAF (MINZ,'SCALE',MAXZ,0.0,'SCALE',MAXA)                   PER12760
      CALL LEGLIN                                                      PER12770
      CALL CURVE (RMR,PIMR,324,0)                                      PER12780
      CALL DASH                                                        PER12790
      CALL CURVE (RMR,POMR,324,0)                                      PER12800
      CALL CHNDOT                                                      PER12810
      CALL CURVE (RMR,PPMR,324,0)                                      PER12820
      CALL CHNDSH                                                      PER12830
      CALL CURVE (RMR,PITR,324,0)                                      PER12840
      CALL DOT                                                         PER12850
      CALL CURVE (RMR,POTR,324,0)                                      PER12860
      IF (VV .LE. 0.0) GO TO 20                                        PER12870
      CALL CURVE (RMR,PCMR,324,0)                                      PER12880
20    MAXLIN=LINEST(TEXT,100,30)                                       PER12890
      CALL HEIGHT(0.1)                                                 PER12900
      CALL LINES('INDUCED POWER (MR)$',TEXT,1)                         PER12910
      CALL LINES('PROFILE POWER (MR)$',TEXT,2)                         PER12920
      CALL LINES('PARASITE POWER (MR)$',TEXT,3)                        PER12930
      CALL LINES('INDUCED POWER (TR)$',TEXT,4)                         PER12940
      CALL LINES('PROFILE POWER (TR)$',TEXT,5)                         PER12950
      CALL LEGEND(TEXT,5,0.4,3.50)                                     PER12960
```

```
      CALL BLREC(0.3,3.42,2.15,1.00,1.1)                                PER12970
      CALL RESET('HEIGHT')                                              PER12980
      CALL DOT                                                          PER12990
      CALL GRID (1,2)                                                   PER13000
      CALL ENDGR(0)                                                     PER13010
C-----------------------------------------------------------------------PER13020
      CALL PHYSOR(5.5,1.5)                                              PER13030
      CALL AREA2D (2.50,4.50)                                           PER13040
      CALL XNAME ('RADIUS OF MAIN ROTOR (% CHANGE)$',100)               PER13050
      CALL YNAME ('POWER REQUIRED (% CHANGE)$',100)                     PER13060
      CALL GRAF (DMIN,'SCALE',DMAX,MINX,'SCALE',MAXX)                   PER13070
      CALL LEGLIN                                                       PER13080
      CALL CURVE (DRMR,DPIMR,324,0)                                     PER13090
      CALL DASH                                                         PER13100
      CALL CURVE (DRMR,DPOMR,324,0)                                     PER13110
      CALL CHNDOT                                                       PER13120
      CALL CURVE (DRMR,DPPMR,324,0)                                     PER13130
      CALL CHNDSH                                                       PER13140
      CALL CURVE (DRMR,DPITR,324,0)                                     PER13150
      CALL DOT                                                          PER13160
      CALL CURVE (DRMR,DPCTR,324,0)                                     PER13170
      IF (VV .LE. 0.0) GO TO 22                                         PER13180
      CALL CURVE (DRMR,DPCMR,322,0)                                     PER13190
   22 MAXLIN=LINEST(TEXT,100,30)                                        PER13200
      CALL HEIGHT(0.1)                                                  PER13210
      CALL LINES('INDUCED POWER (MR)$',TEXT,1)                          PER13220
      CALL LINES('PROFILE POWER (MR)$',TEXT,2)                          PER13230
      CALL LINES('PARASITE POWER (MR)$',TEXT,3)                         PER13240
      CALL LINES('INDUCED POWER (TR)$',TEXT,4)                          PER13250
      CALL LINES('PROFILE POWER (TR)$',TEXT,5)                          PER13260
      CALL LEGEND(TEXT,5,0.4,3.50)                                      PER13270
      CALL BLREC(0.3,3.42,2.2,1.00,1.2)                                 PER13280
      CALL RESET('HEIGHT')                                              PER13290
      CALL DOT                                                          PER13300
      CALL GRID (1,2)                                                   PER13310
      CALL ENDGR(0)                                                     PER13320
C-----------------------------------------------------------------------PER13330
      CALL PHYSOR(1.5,1.5)                                              PER13340
      CALL AREA2D (6.50,4.70)                                           PER13350
      CALL HEADIN (' POWER VERSUS RADIUS$',19,1.4,3)                    PER13360
      IF(K .NE. 1 ) GO TO 8                                             PER13370
      CALL HEADIN ('CHORD & ROTATIONAL VELOCITY HELD CONSTANT$',41,     PER13380
     *             0.8,3)                                               PER13390
      CALL HEADIN ('SOLIDITY, TIP VELOCITY & ADVANCE RATIO$',38,0.8,4)  PER13400
      CALL HEADIN('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)              PER13410
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                           PER13420
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                            PER13430
      CALL MESSAG('CASE 1$',100,8.7,6.0)                                PER13440
```

```
8       IF(K .NE. 2) GO TO 10                                                  PER13450
        CALL HEADIN ('CHORD,TIP VELOCITY & ADVANCE RATIO HELD CONSTANT$',      PER13460
     *       48,0.8,4)                                                         PER13470
        CALL HEADIN ('SOLIDITY, ROTATIONAL VELOCITY$',29,0.8,4)                PER13480
        CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)                  PER13490
        CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                                PER13500
        CALL REALNO (RMR(163),2,'ABUT','ABUT')                                 PER13510
        CALL MESSAG('CASE 2$',100,8.7,6.0)                                     PER13520
10      IF( K .NE. 3) GO TO 12                                                 PER13530
        CALL HEADIN ('SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT$',          PER13540
     *       44,0.8,4)                                                         PER13550
        CALL HEADIN ('CHORD,ADVANCE RATIO & TIP VELOCITY$',34,0.8,4)           PER13560
        CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)                  PER13570
        CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                                PER13580
        CALL REALNO (RMR(163),2,'ABUT','ABUT')                                 PER13590
        CALL MESSAG('CASE 3$',100,8.7,6.0)                                     PER13600
12      IF( K .NE. 4) GO TO 14                                                 PER13610
        CALL HEADIN('SOLIDITY,ADVANCE RATIO & TIP VELOCITY HELD CONSTANT$'     PER13620
     *,51,0.8,4)                                                               PER13630
        CALL HEADIN ('CHORD & ROTATIONAL VELOCITY$',27,0.8,4)                  PER13640
        CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)                  PER13650
        CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                                PER13660
        CALL REALNO (RMR(163),2,'ABUT','ABUT')                                 PER13670
        CALL MESSAG('CASE 4$',100,8.7,6.0)                                     PER13680
14      CALL ENDPL(0)                                                          PER13690
        RETURN                                                                 PER13700
        END                                                                    PER13710
C*************************************************************************   PER13720
C                                                                              PER13730
C    SUBROUTINE TO CREATE GRAPH FOR ENDURANCE VELOCITY VS RADIUS               PER13740
C                                                                              PER13750
C*************************************************************************   PER13760
C*************************************************************************   PER13770
        SUBROUTINE GRAF2                                                       PER13780
        IMPLICIT REAL (A-H,L-Z)                                                PER13790
         COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,         PER13800
     * MAXZ,DMIN,DMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS,TEXT(200)          PER13810
         COMMON /W/ RCMAX(400),DRCMAX(400),VFRAN(400),DVFRAN(400),             PER13820
     * HOVALT(400),DHOVAL(400),SEVALT(400),DSEVAL(400),FMERT(400),            PER13830
     * DFMERT(400),VFEND(400),DVFEND(400)                                      PER13840
         CALL COMPRS                                                           PER13850
         CALL PAGE (11.0,8.5)                                                  PER13860
         CALL PHYSOR(1.5,1.5)                                                  PER13870
         CALL AREA2D (2.50,4.50)                                               PER13880
         CALL XNAME ('RADIUS OF MAIN ROTOR (FT)$',100)                         PER13890
         CALL YNAME ('ENDURANCE VELOCITY (KNOTS)$',100)                        PER13900
         CALL GRAF (MINZ,'SCALE',MAXZ,MIN,'SCALE',MAX)                         PER13910
         CALL CURVE (RMR,VFEND,324,0)                                          PER13920
```

```
      CALL DCT                                                          PER13930
      CALL GRID (1,2)                                                   PER13940
      CALL RESET('DOT')                                                 PER13950
      CALL ENDGR(0)                                                     PER13960
C-----------------------------------------------------------------------PER13970
      CALL PHYSOR(5.5,1.5)                                              PER13980
      CALL AREA2D (2.50,4.50)                                           PER13990
      CALL XNAME ('RADIUS OF MAIN ROTOR (% CHANGE)$',100)               PER14000
      CALL YNAME ('ENDURANCE VELOCITY (% CHANGE)$',100)                 PER14010
      CALL GRAF (DMIN,'SCALE',DMAX,MINY,'SCALE',MAXY)                   PER14020
      CALL CURVE (DRMR,DVFEND,324,0)                                    PER14030
      CALL DCT                                                          PER14040
      CALL GRID (1,2)                                                   PER14050
      CALL ENDGR(0)                                                     PER14060
C-----------------------------------------------------------------------PER14070
      CALL PHYSOR(1.5,1.5)                                              PER14080
      CALL AREA2D (6.50,4.70)                                           PER14090
      CALL HEADIN ('ENDURANCE VELOCITY VERSUS RADIUS$',32,1.4,3)        PER14100
      IF(K .NE. 1 ) GO TO 8                                             PER14110
      CALL HEADIN ('CHORD & ROTATIONAL VELOCITY HELD CONSTANT$',41,      PER14120
     *             0.8,3)                                               PER14130
      CALL HEADIN ('SOLIDITY, TIP VELOCITY & ADVANCE RATIO$',38,0.8,4)  PER14140
      CALL HEADIN('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)              PER14150
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                           PER14160
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                            PER14170
      CALL MESSAG('CASE 1$',100,8.7,6.0)                                PER14180
8     IF(K .NE. 2) GO TO 10                                             PER14190
      CALL HEADIN ('CHORD,TIP VELOCITY & ADVANCE RATIO HELD CONSTANT$',  PER14200
     *     46,0.8,4)                                                    PER14210
      CALL HEADIN ('SOLIDITY, ROTATIONAL VELOCITY$',29,0.8,4)           PER14220
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)             PER14230
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                           PER14240
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                            PER14250
      CALL MESSAG('CASE 2$',100,8.7,6.0)                                PER14260
10    IF( K .NE. 3) GO TO 12                                            PER14270
      CALL HEADIN ('SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT$',      PER14280
     *     44,0.8,4)                                                    PER14290
      CALL HEADIN ('CHORD,ADVANCE RATIO & TIP VELOCITY$',34,0.8,4)      PER14300
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)             PER14310
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                           PER14320
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                            PER14330
      CALL MESSAG('CASE 3$',100,8.7,6.0)                                PER14340
12    IF( K .NE. 4) GO TO 14                                            PER14350
      CALL HEADIN('SOLIDITY,ADVANCE RATIO & TIP VELOCITY HELD CONSTANT$'PER14360
     *,51,0.8,4)                                                        PER14370
      CALL HEADIN ('CHORD & ROTATIONAL VELOCITY$',27,0.8,4)             PER14380
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)             PER14390
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                           PER14400
```

```
      CALL REALNG (RMR(163),2,'ABUT','ABUT')                                PER14410
      CALL MESSAG('CASE 4$',100,8.7,6.0)                                    PER14420
14    CALL ENDPL(0)                                                         PER14430
      RETURN                                                                PER14440
      END                                                                   PER14450
C*********************************************************************     PER14460
C                                                                           PER14470
C     SUBROUTINE TO CREATE GRAPH FOR MAXIMUM RATE OF CLIMB VS RADIUS        PER14480
C                                                                           PER14490
C*********************************************************************     PER14500
C*********************************************************************     PER14510
      SUBROUTINE GRAF3                                                      PER14520
      IMPLICIT REAL (A-H,L-Z)                                               PER14530
       COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,        PER14540
     * MAXZ,DMIN,DMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS,TEXT(200)       PER14550
      COMMON /A/ RCMAX(400),DRCMAX(400),VFRAN(400),DVFRAN(400),             PER14560
     * HOVALT(400),DHOVAL(400),SEVALT(400),DSEVAL(400),FMERT(400),          PER14570
     * DFMERT(400),VFEND(400),DVFEND(400)                                   PER14580
      CALL COMPRS                                                           PER14590
      CALL PAGE (11.0,8.5)                                                  PER14600
      CALL PHYSOR(1.5,1.5)                                                  PER14610
      CALL AREA2D (2.50,4.50)                                               PER14620
      CALL XNAME ('RADIUS OF MAIN ROTOR (FT)$',100)                         PER14630
      CALL YNAME ('MAXIMUM RATE OF CLIMB (FT/SEC)$',100)                    PER14640
      CALL GRAF (MINZ,'SCALE',MAXZ,MIN,'SCALE',MAX)                         PER14650
      CALL CURVE (RMR,RCMAX,324,0)                                          PER14660
      CALL DCT                                                              PER14670
      CALL GRID (1,2)                                                       PER14680
      CALL RESET('DOT')                                                     PER14690
      CALL ENDGR(0)                                                         PER14700
C-------------------------------------------------------------------        PER14710
      CALL PHYSOR(5.5,1.50)                                                 PER14720
      CALL AREA2D (2.50,4.50)                                               PER14730
      CALL XNAME ('RADIUS OF MAIN ROTOR (% CHANGE)$',100)                   PER14740
      CALL YNAME ('MAXIMUM RATE OF CLIMB (% CHANGE)$',100)                  PER14750
      CALL GRAF (DMIN,'SCALE',DMAX,MINY,'SCALE',MAXY)                       PER14760
      CALL CURVE (DRMR,DRCMAX,324,0)                                        PER14770
      CALL DCT                                                              PER14780
      CALL GRID (1,2)                                                       PER14790
      CALL ENDGR(0)                                                         PER14800
C-------------------------------------------------------------------        PER14810
      CALL PHYSOR(1.5,1.5)                                                  PER14820
      CALL AREA2D (6.50,4.70)                                               PER14830
      CALL HEADIN ('MAXIMUM RATE OF CLIMB VERSUS RADIUS CHANGE$',           PER14840
     *   42,1.4,4)                                                          PER14850
      IF(K .NE. 1 ) GO TO 8                                                 PER14860
      CALL HEADIN ('CHORD & ROTATIONAL VELOCITY HELD CONSTANT$',41,         PER14870
     *            0.8,3)                                                  PER14880
```

```
      CALL HEADIN ('SOLIDITY, TIP VELOCITY & ADVANCE RATIO$',38,0.8,4)   PER14890
      CALL HEADIN('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)               PER14900
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                            PER14910
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                             PER14920
      CALL MESSAG('CASE 1$',100,8.7,6.0)                                 PER14930
8     IF(K .NE. 2) GO TO 10                                              PER14940
      CALL HEADIN ('CHORD,TIP VELOCITY & ADVANCE RATIO HELD CONSTANT$',  PER14950
     *     46,0.8,4)                                                     PER14960
      CALL HEADIN ('SOLIDITY, ROTATIONAL VELOCITY$',29,0.8,4)            PER14970
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)              PER14980
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                            PER14990
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                             PER15000
      CALL MESSAG('CASE 2$',100,8.7,6.0)                                 PER15010
10    IF( K .NE. 3) GO TO 12                                             PER15020
      CALL HEADIN ('SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT$',      PER15030
     *     44,0.8,4)                                                     PER15040
      CALL HEADIN ('CHORD,ADVANCE RATIO & TIP VELOCITY$',34,0.8,4)       PER15050
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)              PER15060
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                            PER15070
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                             PER15080
      CALL MESSAG('CASE 3$',100,8.7,6.0)                                 PER15090
12    IF( K .NE. 4) GO TO 14                                             PER15100
      CALL HEADIN('SOLIDITY,ADVANCE RATIO & TIP VELOCITY HELD CONSTANT$' PER15110
     *,51,0.8,4)                                                         PER15120
      CALL HEADIN ('CHORD & ROTATIONAL VELOCITY$',27,0.8,4)              PER15130
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)              PER15140
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                            PER15150
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                             PER15160
      CALL MESSAG('CASE 4$',100,8.7,6.0)                                 PER15170
14    CALL ENDPL(0)                                                      PER15180
      RETURN                                                             PER15190
      END                                                                PER15200
C*************************************************************          PER15210
C                                                                        PER15220
C     SUBROUTINE TO CREATE GRAPH FOR MAXIMUM RANGE VELOCITY VS RADIUS    PER15230
C                                                                        PER15240
C*************************************************************************PER15250
C*************************************************************************PER15260
      SUBROUTINE GRAF4                                                   PER15270
      IMPLICIT REAL (A-H,L-Z)                                            PER15280
       COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,     PER15290
     * MAXZ,DMIN,DMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS,TEXT(200)    PER15300
       COMMON /W/ RCMAX(400),DRCMAX(400),VFRAN(400),DVFRAN(400),         PER15310
     * HOVALT(400),DHOVAL(400),SEVALT(400),DSEVAL(400),FMERT(400),      PER15320
     * DFMERT(400),VFEND(400),DVFEND(400)                               PER15330
      CALL COMPRS                                                        PER15340
      CALL PAGE (11.0,8.5)                                               PER15350
      CALL PHYSOR(1.5,1.5)                                               PER15360
```

```
      CALL AREA2D (2.50,4.50)                                                PER15370
      CALL XNAME ('RADIUS OF MAIN ROTOR (FT)$',100)                          PER15380
      CALL YNAME ('MAXIMUM RANGE VELOCITY (KNOTS)$',100)                     PER15390
      CALL GRAF (MINZ,'SCALE',MAXZ,MIN,'SCALE',MAX)                          PER15400
      CALL CURVE (RMR,VFRAN,324,-1 )                                         PER15410
      CALL DOT                                                               PER15420
      CALL GRID (1,2)                                                        PER15430
      CALL RESET('DOT')                                                      PER15440
      CALL ENDGR(0)                                                          PER15450
C*************************************************************************PER15460
      CALL PHYSOR(5.5,1.5)                                                   PER15470
      CALL AREA2D (2.5,4.5)                                                  PER15480
      CALL XNAME ('RADIUS OF MAIN ROTOR (% CHANGE)$',100)                    PER15490
      CALL YNAME ('MAXIMUM RANGE VELOCITY (% CHANGE)$',100)                  PER15500
      CALL GRAF (DMIN,'SCALE',DMAX,MINY,'SCALE',MAXY)                        PER15510
      CALL CURVE (DRMR,DVFRAN,324,-1)                                        PER15520
      CALL DOT                                                               PER15530
      CALL GRID (1,2)                                                        PER15540
      CALL ENDGR(0)                                                          PER15550
C-------------------------------------------------------------------------PER15560
      CALL PHYSOR(1.5,1.5)                                                   PER15570
      CALL AREA2D (6.50,4.70)                                                PER15580
      CALL HEADIN ('MAXIMUM RANGE VELOCITY VERSUS RADIUS CHANGE$',           PER15590
     *    43,1.4,4)                                                         PER15600
      IF(K .NE. 1 ) GO TO 8                                                  PER15610
      CALL HEADIN ('CHORD & ROTATIONAL VELOCITY HELD CONSTANT$',41,          PER15620
     *            0.8,3)                                                    PER15630
      CALL HEADIN ('SOLIDITY, TIP VELOCITY & ADVANCE RATIO$',38,0.8,4)       PER15640
      CALL HEADIN('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)                   PER15650
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                                PER15660
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                                 PER15670
      CALL MESSAG('CASE 1$',100,8.7,6.0)                                     PER15680
8     IF(K .NE. 2) GO TO 10                                                  PER15690
      CALL HEADIN ('CHORD,TIP VELOCITY & ADVANCE RATIO HELD CONSTANT$',      PER15700
     *     48,0.8,4)                                                        PER15710
      CALL HEADIN ('SOLIDITY, ROTATIONAL VELOCITY$',29,0.8,4)                PER15720
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)                  PER15730
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                                PER15740
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                                 PER15750
      CALL MESSAG('CASE 2$',100,8.7,6.0)                                     PER15760
10    IF( K .NE. 3) GO TO 12                                                 PER15770
      CALL HEADIN ('SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT$',          PER15780
     *     44,0.8,4)                                                        PER15790
      CALL HEADIN ('CHORD,ADVANCE RATIO & TIP VELOCITY$',34,0.8,4)           PER15800
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)                  PER15810
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                                PER15820
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                                 PER15830
      CALL MESSAG('CASE 3$',100,8.7,6.0)                                     PER15840
```

```
12     IF( K .NE. 4) GO TO 14                                                  PER15850
       CALL HEADIN('SOLIDITY,ADVANCE RATIO & TIP VELOCITY HELD CONSTANT$'PER15860
      *,51,0.8,4)                                                            PER15870
       CALL HEADIN ('CHORD & ROTATIONAL VELOCITY$',27,0.8,4)                  PER15880
       CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)                  PER15890
       CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                                PER15900
       CALL REALNO (RMR(163),2,'ABUT','ABUT')                                 PER15910
       CALL MESSAG('CASE 4$',100,8.7,6.0)                                     PER15920
14     CALL ENDPL(0)                                                          PER15930
       RETURN                                                                 PER15940
       END                                                                    PER15950
C*************************************************************************** PER15960
C                                                                              PER15970
C      SUBROUTINE TO CREATE GRAPH FOR MAXIMUM HOVER CEILING                    PER15980
C                                                                              PER15990
C*************************************************************************** PER16000
C*************************************************************************** PER16010
       SUBROUTINE GRAF5                                                       PER16020
       IMPLICIT REAL (A-H,L-Z)                                                PER16030
        COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,         PER16040
      * MAXZ,DMIN,DMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS,TEXT(200)        PER16050
       COMMON /W/ RCMAX(400),DRCMAX(400),VFRAN(400),DVFRAN(400),              PER16060
      * HOVALT(400),DHOVAL(400),SEVALT(400),DSEVAL(400),FMERT(400),          PER16070
      * DFMERT(400),VFEND(400),DVFEND(400)                                    PER16080
       CALL COMPRS                                                            PER16090
       CALL PAGE (11.0,8.5)                                                   PER16100
       CALL PHYSOR(1.5,1.5)                                                   PER16110
       CALL AREA2D (2.50,4.50)                                                PER16120
       CALL XNAME ('RADIUS OF MAIN ROTOR (FT)$',100)                          PER16130
       CALL YNAME ('MAXIMUM HOVER CEILING (FT)$',100)                         PER16140
       CALL GRAF (MINZ,'SCALE',MAXZ,MIN,'SCALE',MAX)                          PER16150
       CALL CURVE (RMR,HOVALT,324,0)                                          PER16160
       CALL DOT                                                               PER16170
       CALL GRID (1,2)                                                        PER16180
       CALL RESET('DOT')                                                      PER16190
       CALL ENDGR(0)                                                          PER16200
C------------------------------------------------------------------------------PER16210
       CALL PHYSOR(5.5,1.50)                                                  PER16220
       CALL AREA2D (2.50,4.50)                                                PER16230
       CALL XNAME ('RADIUS OF MAIN ROTOR (% CHANGE)$',100)                    PER16240
       CALL YNAME ('MAXIMUM HOVER CEILING (% CHANGE)$',100)                   PER16250
       CALL GRAF (DMIN,'SCALE',DMAX,MINY,'SCALE',MAXY)                        PER16260
       CALL CURVE (DRMR,DHOVAL,324,0)                                         PER16270
       CALL DOT                                                               PER16280
       CALL GRID (1,2)                                                        PER16290
       CALL ENDGR(0)                                                          PER16300
C------------------------------------------------------------------------------PER16310
       CALL PHYSOR(1.5,1.5)                                                   PER16320
```

```
      CALL AREA2D (6.50,4.70)                                          PER16330
      CALL HEADIN ('MAXIMUM HOVER CEILING (IGE) VERSUS RADIUS$',       PER16340
     *   41,1.2,4)                                                     PER16350
      IF(K .NE. 1 ) GO TO 8                                            PER16360
      CALL HEADIN ('CHORD & ROTATIONAL VELOCITY HELD CONSTANT$',41,     PER16370
     *            0.8,3)                                               PER16380
      CALL HEADIN ('SOLIDITY, TIP VELOCITY & ADVANCE RATIO$',38,0.8,4) PER16390
      CALL HEADIN('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)             PER16400
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                          PER16410
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                           PER16420
      CALL MESSAG('CASE 1$',100,8.7,6.0)                               PER16430
8     IF(K .NE. 2) GO TO 10                                            PER16440
      CALL HEADIN ('CHORD,TIP VELOCITY & ADVANCE RATIO HELD CONSTANT$', PER16450
     *     48,0.8,4)                                                   PER16460
      CALL HEADIN ('SOLIDITY, ROTATIONAL VELOCITY$',29,0.8,4)          PER16470
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)            PER16480
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                          PER16490
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                           PER16500
      CALL MESSAG('CASE 2$',100,8.7,6.0)                               PER16510
10    IF( K .NE. 3) GO TO 12                                           PER16520
      CALL HEADIN ('SOLICITY & ROTATIONAL VELOCITY HELD CONSTANT$',     PER16530
     *     44,0.8,4)                                                   PER16540
      CALL HEADIN ('CHORD,ADVANCE RATIO & TIP VELOCITY$',34,0.8,4)     PER16550
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)            PER16560
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                          PER16570
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                           PER16580
      CALL MESSAG('CASE 3$',100,8.7,6.0)                               PER16590
12    IF( K .NE. 4) GO TO 14                                           PER16600
      CALL HEADIN('SOLIDITY,ADVANCE RATIO & TIP VELOCITY HELD CONSTANT$'PER16610
     *,51,0.8,4)                                                       PER16620
      CALL HEADIN ('CHORD & ROTATIONAL VELOCITY$',27,0.8,4)            PER16630
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)            PER16640
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                          PER16650
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                           PER16660
      CALL MESSAG('CASE 4$',100,8.7,6.0)                               PER16670
14    CALL ENDPL(0)                                                    PER16680
      RETURN                                                           PER16690
      END                                                              PER16700
C*****************************************************************    PER16710
C                                                                      PER16720
C     SUBROUTINE TO CREATE GRAPH FOR MAXIMUM SERVIVE CEILING           PER16730
C                                                                      PER16740
C*****************************************************************    PER16750
C*****************************************************************    PER16760
      SUBROUTINE GRAF6                                                 PER16770
      IMPLICIT REAL (A-H,L-Z)                                          PER16780
       COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,   PER16790
     * MAXZ,CMIN,CMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS,TEXT(200)  PER16800
```

```
      COMMON /W/ RCMAX(400),DRCMAX(400),VFRAN(400),DVFRAN(400),          PER16810
     * HCVALT(400),DHOVAL(400),SEVALT(400),DSEVAL(400),FMERT(400),       PER16820
     * DFMERT(400),VFEND(400),DVFEND(400)                                PER16830
      CALL COMPRS                                                       PER16840
      CALL PAGE (11.0,8.5)                                              PER16850
      CALL PHYSOR(1.5,1.5)                                              PER16860
      CALL AREA2D (2.50,4.50)                                           PER16870
      CALL XNAME ('RADIUS OF MAIN ROTOR (FT)$',100)                     PER16880
      CALL YNAME ('MAXIMUM SERVICE CEILING (FT)$',100)                  PER16890
      CALL GRAF (MINZ,'SCALE',MAXZ,MIN,'SCALE',MAX)                     PER16900
      CALL CURVE (RMR,SEVALT,322,0)                                     PER16910
      CALL DOT                                                          PER16920
      CALL GRID (1,2)                                                   PER16930
      CALL RESET('DOT')                                                 PER16940
      CALL ENDGR(0)                                                     PER16950
C-----------------------------------------------------------------------PER16960
      CALL PHYSOR(5.5,1.5)                                              PER16970
      CALL AREA2D (2.50,4.50)                                           PER16980
      CALL XNAME ('RADIUS OF MAIN ROTOR (% CHANGE)$',100)               PER16990
      CALL YNAME ('MAXIMUM SERVICE CEILING (% CHANGE)$',100)            PER17000
      CALL GRAF (DMIN,'SCALE',DMAX,MINY,'SCALE',MAXY)                   PER17010
      CALL CURVE (DRMR,DSEVAL,324,0)                                    PER17020
      CALL DOT                                                          PER17030
      CALL GRID (1,2)                                                   PER17040
      CALL ENDGR(0)                                                     PER17050
C-----------------------------------------------------------------------PER17060
      CALL PHYSOR(1.5,1.5)                                              PER17070
      CALL AREA2D (6.50,4.70)                                           PER17080
      CALL HEADIN ('MAXIMUM SERVICE CEILING VERSUS RADIUS CHANGE$',     PER17090
     *   44,1.4,4)                                                      PER17100
      IF(K .NE. 1 ) GO TO 8                                             PER17110
      CALL HEADIN ('CHORD & ROTATIONAL VELOCITY HELD CONSTANT$',41,     PER17120
     *            0.8,3)                                              PER17130
      CALL HEADIN ('SOLIDITY, TIP VELOCITY & ADVANCE RATIO$',38,0.8,4)  PER17140
      CALL HEADIN('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)              PER17150
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                           PER17160
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                            PER17170
      CALL MESSAG('CASE 1$',100,8.7,6.0)                                PER17180
8     IF(K .NE. 2) GO TO 10                                             PER17190
      CALL HEADIN ('CHORD,TIP VELOCITY & ADVANCE RATIO HELD CONSTANT$', PER17200
     *      48,0.8,4)                                                   PER17210
      CALL HEADIN ('SOLIDITY, ROTATIONAL VELOCITY$',29,0.8,4)           PER17220
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)             PER17230
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                           PER17240
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                            PER17250
      CALL MESSAG('CASE 2$',100,8.7,6.0)                                PER17260
10    IF( K .NE. 3) GO TO 12                                            PER17270
      CALL HEADIN ('SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT$',     PER17280
```

```
     *     44,C.8,4)                                                        PER17290
           CALL HEADIN ('CHORD,ADVANCE RATIO & TIP VELOCITY$',34,0.8,4)     PER17300
           CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)            PER17310
           CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                          PER17320
           CALL REALNO (RMR(163),2,'ABUT','ABUT')                           PER17330
           CALL MESSAG('CASE 3$',100,8.7,6.0)                               PER17340
12         IF( K .NE. 4) GO TO 14                                           PER17350
           CALL HEADIN('SOLIDITY,ADVANCE RATIC & TIP VELOCITY HELD CONSTANT$'PER17360
          *,51,0.8,4)                                                       PER17370
           CALL HEADIN ('CHORD & ROTATIONAL VELOCITY$',27,0.8,4)            PER17380
           CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)            PER17390
           CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                          PER17400
           CALL REALNO (RMR(163),2,'ABUT','ABUT')                           PER17410
           CALL MESSAG('CASE 4$',100,8.7,6.0)                               PER17420
14         CALL ENDPL(0)                                                    PER17430
           RETURN                                                           PER17440
           END                                                              PER17450
C*************************************************************************PER17460
C                                                                           PER17470
C      SUBROUTINE TO CREATE GRAPH OF FIGURE OF MERIT VS RADIUS              PER17480
C                                                                           PER17490
C*************************************************************************PER17500
C*************************************************************************PER17510
           SUBROUTINE GRAFIE                                                PER17520
           IMPLICIT REAL (A-H,L-Z)                                          PER17530
            COMMON /C/ RMR(400),I,J,K,DRMR(400),MINX,MAXX,MINY,MAXY,MINZ,   PER17540
          * MAXZ,CMIN,CMAX,MINB,MAXB,MINC,MAXC,MIN,MAX,MAXA,IANS,TEXT(200)  PER17550
           COMMON /W/ RCMAX(400),DRCMAX(400),VFRAN(400),DVFRAN(400),        PER17560
          * HOVALT(400),DHOVAL(400),SEVALT(400),DSEVAL(400),FMERT(400),     PER17570
          * DFMERT(400),VFEND(400),DVFEND(400)                              PER17580
           CALL COMPRS                                                      PER17590
           CALL PAGE (11.0,8.5)                                             PER17600
           CALL PHYSOR(1.5,1.5)                                             PER17610
           CALL AREA2D (2.50,4.50)                                          PER17620
           CALL XNAME ('RADIUS OF MAIN ROTOR (FT)$',100)                    PER17630
           CALL YNAME ('FIGUURE OF MERIT$',100)                             PER17640
           CALL GRAF (MINZ,'SCALE',MAXZ,MINB,'SCALE',MAXB)                  PER17650
           CALL CURVE (RMR,FMERT,324,0)                                     PER17660
           CALL DOT                                                         PER17670
           CALL GRID (1,2)                                                  PER17680
           CALL RESET('DOT')                                                PER17690
           CALL ENDGR(0)                                                    PER17700
C----------------------------------------------------------------------     PER17710
           CALL PHYSOR(5.5,1.5)                                             PER17720
           CALL AREA2D (2.50,4.50)                                          PER17730
           CALL XNAME ('RADIUS OF MAIN ROTOR (% CHANGE)$',100)              PER17740
           CALL YNAME ('FIGURE OF MERIT (% CHANGE)$',100)                   PER17750
           CALL GRAF (CMIN,'SCALE',CMAX,MINC,'SCALE',MAXC)                  PER17760
```

```
      CALL CURVE (DRMR,DFMERT,324,0)                                    PER17770
      CALL DOT                                                          PER17780
      CALL GRID (1,2)                                                   PER17790
      CALL ENDGR(0)                                                     PER17800
C-----------------------------------------------------------------------PER17810
      CALL PHYSOR(1.5,1.5)                                              PER17820
      CALL AREA2D (6.50,4.70)                                           PER17830
      CALL HEADIN ('FIGURE OF MERIT VERSUS RADIUS CHANGE$',             PER17840
     *   36,1.4,4)                                                      PER17850
      IF(K .NE. 1 ) GO TO 8                                             PER17860
      CALL HEADIN ('CHORD & ROTATIONAL VELOCITY HELD CONSTANT$',41,     PER17870
     *            0.8,3)                                              PER17880
      CALL HEADIN ('SOLIDITY, TIP VELOCITY & ADVANCE RATIO$',38,0.8,4)  PER17890
      CALL HEADIN('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)              PER17900
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                           PER17910
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                            PER17920
      CALL MESSAG('CASE 1$',100,8.7,6.0)                                PER17930
8     IF(K .NE. 2) GO TO 10                                             PER17940
      CALL HEADIN ('CHORD,TIP VELOCITY & ADVANCE RATIO HELD CONSTANT$', PER17950
     *     46,0.8,4)                                                    PER17960
      CALL HEADIN ('SOLIDITY, ROTATIONAL VELOCITY$',29,0.8,4)           PER17970
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)             PER17980
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                           PER17990
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                            PER18000
      CALL MESSAG('CASE 2$',100,8.7,6.0)                                PER18010
10    IF( K .NE. 3) GO TO 12                                            PER18020
      CALL HEADIN ('SOLIDITY & ROTATIONAL VELOCITY HELD CONSTANT$',     PER18030
     *     44,0.8,4)                                                    PER18040
      CALL HEADIN ('CHORD,ADVANCE RATIO & TIP VELOCITY$',34,0.8,4)      PER18050
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)             PER18060
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                           PER18070
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                            PER18080
      CALL MESSAG('CASE 3$',100,8.7,6.0)                                PER18090
12    IF( K .NE. 4) GO TO 14                                            PER18100
      CALL HEADIN('SOLIDITY,ADVANCE RATIO & TIP VELOCITY HELD CONSTANT$'PER18110
     *,51,0.8,4)                                                        PER18120
      CALL HEADIN ('CHORD & ROTATIONAL VELOCITY$',27,0.8,4)             PER18130
      CALL HEADIN ('ALLOWED TO VARY WITH RADIUS$',27,0.8,4)             PER18140
      CALL MESSAG ('SPEC RMR =$',100,7.4,6.5)                           PER18150
      CALL REALNO (RMR(163),2,'ABUT','ABUT')                            PER18160
      CALL MESSAG('CASE 4$',100,8.7,6.0)                                PER18170
14    CALL ENDPL(0)                                                     PER18180
      RETURN                                                            PER18190
      END                                                               PER18200
C=======================================================================PER18210
C                                                                       PER18220
C  SUBROUTINE RDINT -- INTERACTIVELY READS AN INTEGER REPLY             =PER18230
C  INTO A FORTRAN PROGRAM.  IF THE USER INADVERTENLY ENTERS AN IMPROPER=PER18240
```

```
C  DATA CHARACTER THE S/R ISSUES A WARNING AND ALLOWS A RECOVERY.      =PER18250
C                                                                      PER18260
C======================================================================PER18270
      SUBROUTINE RDINT (IANS)                                          PER18280
      INTEGER COUNT                                                    PER18290
C---------------------------------------------------------------------PER18300
      COUNT=0                                                          PER18310
10    CONTINUE                                                         PER18320
      COUNT=COUNT+1                                                    PER18330
      IF (COUNT.LT.3) GO TO 20                                         PER18340
      WRITE (5,60)                                                     PER18350
      GO TO 50                                                         PER18360
20    CONTINUE                                                         PER18370
      READ (5,*,END=40,ERR=40) IANS                                    PER18380
      IF (IANS) 40,40,30                                               PER18390
30    CONTINUE                                                         PER18400
      RETURN                                                           PER18410
40    REWIND 5                                                         PER18420
      WRITE (5,70)                                                     PER18430
      GO TO 10                                                         PER18440
50    CONTINUE                                                         PER18450
      STOP                                                             PER18460
C---------------------------------------------------------------------PER18470
60    FORMAT (//,5X,49HPROGRAM TERMINATION - TWO IMPROPER DATA ENTRIES  PER18480
     1)                                                                PER18490
70    FORMAT (1X,56HWARNING: IMPROPER DATA ENTRY   ENTER A POSITIVE INTEPER18500
     1GER.)                                                            PER18510
      END                                                              PER18520
```

LIST OF REFERENCES

1. Integrated Software Systems Corporation, DISSPLA : Pocket Guide, Version 9.0, 1981.

2. Layton, Professor Donald M., Helicopter Performance, Naval Postgraduate School, Monterey California, 1983.

3. Layton, Professor Donald M., AE 4306 Design Design Manual, Naval Postgraduate School, Monterey California, 1983.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Technical Information Center Cameron Station Alexandria, Virginia 22314	2
2.	Army Aviation Systems Command Attn: Mr Crawford DRAV-GT 4300 Goodfellow Blvd St. Louis, Missouri 63120	1
3.	Library, Code 0142 Naval Postgraduate School Monterey, California 93943	2
4.	Department Chairman, Code 67 Department of Aeronautics Naval Postgraduate School Monterey, California 93943	1
5.	Prof Donald M. Layton, Code 67-LN Department of Aeronautics Naval Postgraduate School Monterey, California 93943	5
6.	CPT Patrick V. Adamcik c/o CPT Steve Kee 302 Lakeshore Road Enterprise, Alabama 36330	4

13537 5

Thesis
A222 Adamcik
c.1 Preliminary helicopter design decision making based on flight performance factors.

Thesis
A222 Adamcik
c.1 Preliminary helicopter design decision making based on flight performance factors.

thesA222
Preliminary helicopter design decision m
3 2768 001 90901 3
DUDLEY KNOX LIBRARY